THE

BOTANICAL GAZETTE

EDITORS:

JOHN M. COULTER, Lake Forest University, Lake Forest, Ill.
CHARLES R. BARNES, University of Wisconsin, Madison, Wis.
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ERRATA.

p. 3, line 6 from bottom, for "avatis" read ovatis.
p. 3, line 5 from bottom, for "villose" read villoso.
p. 4, line 22, for "latio" read latis.
p. 9, line 21, for "pynctulatis" read punctulatis.
p. 12, line 17 from bottom, insert comma after verticillate.
p. 23, line 5, for "á" read *a*.
p. 54, line 9 of footnote, for "those" read these.
p. 54, line 13 of footnote, for "Sapromytces" read Sapromyces.
p. 86, line 12 from bottom, for "-redium" read -pedium.
p. 86, line 6 from bottom, for "*Kcw*" read *Kew*.
p. 118, line 3 from bottom, for "slender" read several.
p. 151, line 16, for "Lindb." read Lindl.
p. 191, line 9 from bottom, for "omits" read limits.
p. 191, line 8 from bottom, for "line" read one.
p. 199, line 11, for "definite" read definitive.
p. 199, line 15, for "definitely" read definitively.
p. 253, line 23, for "Name" read Maine.
p. 253, line 6 from bottom, for "Osterhaut" read Osterhout.
p. 253, line 4 from bottom, for "he" read we; for "sent" read send.
p. 255, line 11, for "ovata" read ovato.
p. 255, line 19, *dele* comma at end of line.
p. 256, line 7 from bottom, for "Layas" read Lajas.
p. 257, line 2, for "infirma" read infima.
p. 268, line 8 from bottom, for "**132**" read **13^2**.
p. 269, line 22, enclose "in part" in parentheses.
p. 269, line 6 from bottom, insert comma after "thin."
p. 270, line 15 from bottom, *dele* comma before Anderss., and after ined. insert ex Gray, *l. c.*
p. 271, line 12, for "petiole" read petioles.
p. 272, line 7 from bottom, *dele* Sonora.
p. 277, line 5, for "Donnelli" read Donnellii.
p. 281, line 9, after "attachment" add of the cilia.
p. 308, line 6 from bottom, for "appeared" read appears.
p. 312, line 14, for "on" read after.
p. 364, line 15 from bottom, for "L. L." read N. L.
p. 385, line 6, for "funi" read fungi.
p. 415, line 3, for "myt" read my-.
p. 450, line 21, for "Neves" read Meves.
p. 455, lines 11 and 19, for "45°" read 90°.

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In the February number will appear:

Observations on Nægeliella, by DR. ROLAND THAXTER, *Harvard University, Cambridge, Mass.*

On some species of Micrasterias, by L. N. JOHNSON, *University of Michigan, Ann Arbor.*

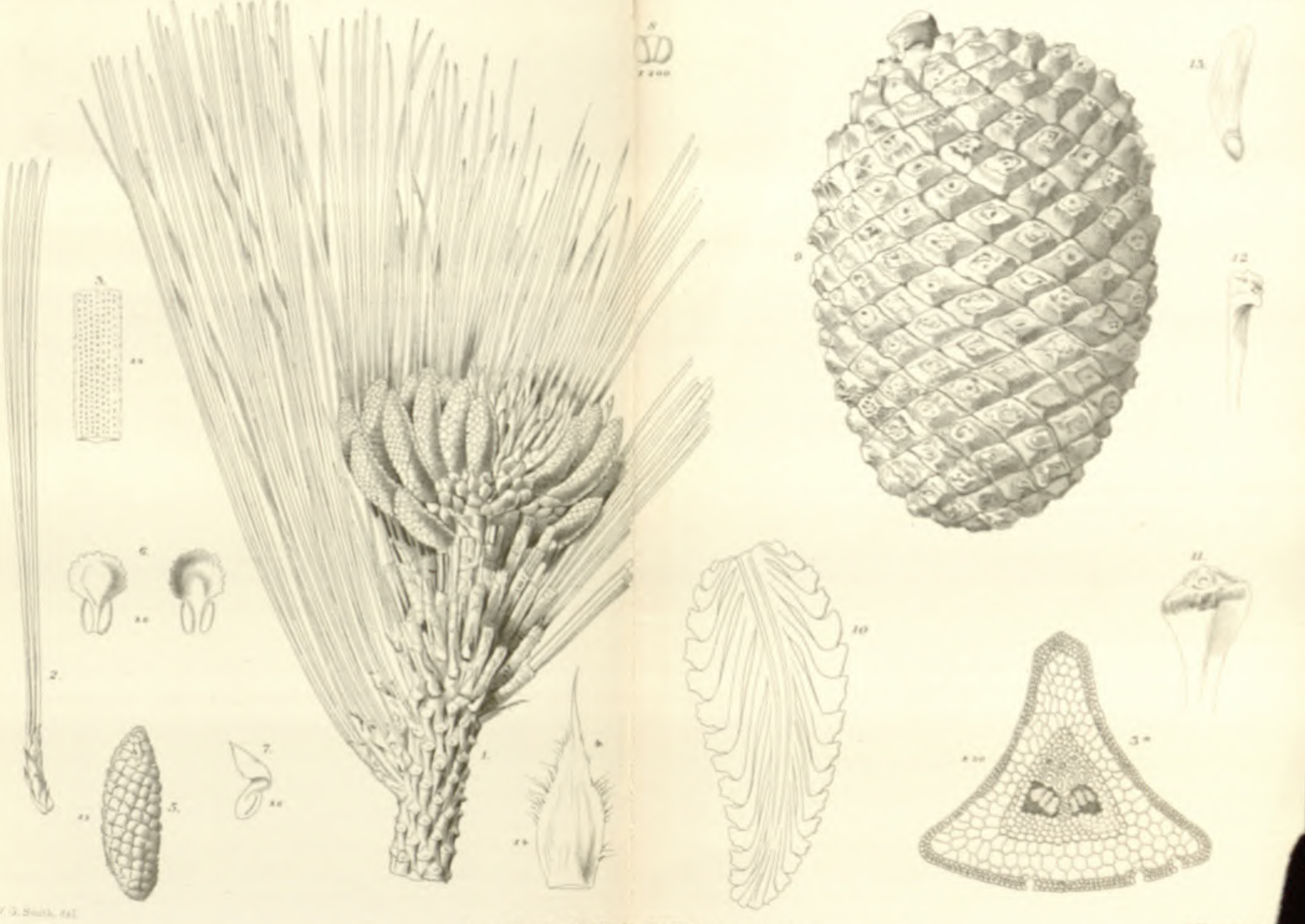
On the development of the bulb of the adder's-tongue, by FREDERICK H. BLODGETT, *Rutgers College, New Brunswick, N. J.*

Noteworthy anatomical and physiological researches, by TH. HOLM and J. C. BAY.

C. E. Faxon, del.

B. Meisel, Lith. Boston.

ARDISIA PASCHALIS, n. sp.



W. G. Smith, del.

PINUS DONNELL-SMITHII. Mast.

B. Meisel, Lith. Bos.

BOTANICAL GAZETTE

JANUARY, 1894.

Undescribed plants from Guatemala. XII.

JOHN DONNELL SMITH.

WITH PLATES I AND II.

M. Casimir de Candolle has contributed to this article diagnoses and descriptions of new species among the MELIACEÆ and PIPERACEÆ submitted to him for elaboration.

Peltostigma pentaphyllum.—Petioles half to two-thirds as long as leaves; leaflets 5, obovate-oblong to elliptical-oblong (6–8 × 2–2.5^{in}), the exterior pair reduced, acuminate, tapering to petiolule, entire: peduncle with 3-flowered cyme subequalling petiole, pedicels ebracteate: sepals chiefly 4; 2 exterior herbaceous, ovate (1–2^{l}): petals chiefly 5, exceeding interior sepal (8^{l}): ovary 7–10-locular, truncate-conic, as broad as gynophore (3^{l}); stigmas before anthesis sacciform, oval (1.5 × 1^{l}); capsule globose, the matured not seen.—A tree 15–21^{ft} high with spreading branches. *P. pteleoides* Walp., which has been the monotype of the genus, and recorded only from Jamaica, differs by short petioles, ternate smaller leaflets, compound inflorescence equalling leaves, smaller flowers, less numerous and less unequal parts of perianth.—Zamorora, Depart. Santa Rosa, alt. 5,500^{ft}, March 1892 and April 1893, Heyde & Lux, (ex Pl. Guatemal. qu. edid. J. D. S. 3,058 and 4,437).

Cabralea insignis C. DC.—Foliis maximis modice petiolatis abrupto-pinnatis 19-jugis, foliolis oppositis sessilibus anguste oblongis basi æquali subacutis obtusisve apice obtusiuscule cuspidatis utrinque glabris, nervis secundariis subpatulis tenuibus utrinque 25 et plus, fructu globoso glabro loculis monospermis.—Arbor? Folium totum ad 65^{cm} longum. Foliola ad 14.5^{cm} longa 2.5^{cm} lata in sicco membranacea subpellucida læte virescentia subtiliter pellucido-punctulata verruculis porosis destituta. Rhachis teres. Petiolus 10^{cm} longus. Fructus indehiscens circiter 4.5^{cm} in diametro, lævis in sicco fuscescens. Semina elliptica circiter 18^{mm} longa. Cotyledones carnosi coriacei elliptici, radicula intra cotyledones immersa.—Species magnitudine foliorum insignis, *C. pallescentis* C. DC. subaffinis.—Acatepeque, Depart. Zacatepequez, alt. $4,300^{ft}$, March 1892, J. D. S., no. 2,570.

Guarea Luxii C. DC.—Foliis modice petiolatis 3-jugis, foliolis brevissime petiolulatis oppositis lanceolatis subæqualibus supra glabris subtus junioribus adpresse pilosulis cito glabris, rhachi adpresse hirsuta, paniculis quam folii dimidium brevioribus simplicibus modice pedunculatis spicatim cymuligeris, floribus longiuscule pedicellatis, calyce cupuliformi extus adpresse hirtello margine brevissime acute 4-denticulato, petalis glabris oblongis apice acutis, tubo glabro cylindrico margine obtuse 8-crenulato, antheris oblongis glabris, ovario glabro ovato stipitem superante apice in stylum glabrum attenuato.—Frutex aut arbor $4–6^{m}$ alta, ramulis junioribus adpresse pubescentibus cito glabris lævibus subcinerascentibus, fructiferis in sicco circiter 2^{mm} crassis. Foliola in sicco membranacea firmulave subpellucida crebre minute pellucido-punctulata ad 9.5^{cm} longa et ad 3^{cm} lata, nervis secundariis subpatulis tenuibus utrinque circiter 15. Petioluli vix 2^{mm} longi. Petioli ad 5^{cm} longi. Flores circiter 3^{mm} longi. Petala 4 æstivatione valvata in sicco rubescentia. Antheræ 8 tubi denticulis oppositæ parvæ. Ovarium 4-loculare loculis uniovulatis. Capsula in specimine nondum matura subglobosa glabra circiter 12^{mm} longa.—Species *G. pedicellatæ* C. DC. et *G. Shomburgkii* C. DC. affinis.—S. Rosa, Depart. S. Rosa, alt. $3,000^{ft}$, March 1892, Heyde & Lux, no. 3,276.

Trichilia Donnell-Smithii C. DC.—Foliis modice petiolatis 4–5-jugis, foliolis breviter petiolulatis plerumque oppositis subæqualibus e basi cuneata obovato-oblongis apice rotundatis obtusisve vel breviter obtusiuscule acuminatis utrinque breviter haud dense pilosulis, paniculis e basi decompositis quam petioli brevioribus, floribus longiuscule pedicellatis, calyce acute profunde 5-dentato extus dense hirtello, petalis 5 extus adpresse hirtellis ellipticis apice subacutis, staminibus medium usque in tubum urceolatum glabrum connatis sursum laciniosis laciniis utrinque pilosis apice acute 2-dentatis, antheris 10 glabris oblongis apice acutis, ovario globoso glabro in disco carnoso glabro subcupuliformi insidente 3-loculari, loculis 2-ovulatis, capsulæ glabræ 3-valvatæ loculis monospermis, seminibus ellipticis arilloque rubris.—Ramuli juniores hirsuti dein subglabri in sicco fuscescentes elenticellosi. Folia ad 16^{cm} longa. Foliola ad 8^{cm} longa ad 2.5^{cm} lata in sicco firma subopaca epunctata, nervis secundariis plerumque alternis subadscendentibus utrinque circiter 8–10. Rhachis cum petiolo 3^{cm} longo teres hirtella. Floris pedicellus 2^{mm} longus. Petala 9^{mm} longa in sicco flavicantia. Antheræ inter laciniarum dentes sessiles. Ovarii loculi oppositisepali, ovulis superpositis. Stylus glaber ovario æquilongus. Seminis testa dura. Embryo intra perispermium album carnosum inclusus, cotyledonibus foliaceis elliptico-rotundatis basi breviter cordulatis, radicula exserta brevi, plumula minima. — Species quoad floris structuram in sectione EUTRICHILIA *(C.DC. monogr.)* collocanda sed propter semen perispermium includens ab omnibus Trichiliis quorum fructus notus discrepans.—Laguna Amatitlan, Depart. Amatitlan, alt. $3,900^{ft}$, March 1890, J. D. S., no. 1,908; Volcan de Fuego, Depart. Zacatepequez, alt. $5,500^{ft}$, March 1892, J. D. S., 2,504.

Var. *β*. **Uniovulata** C. DC.—Staminum laciniis extus glabris, ovarii loculi uniovulati. — Folia inferiora 1–2-juga cum impari foliolis lateralibus multum majore ad 9^{cm} longo et ad 5^{cm} lato, superiora ut in specie.—Guarda Viejo, Depart. Guatemala, alt. $5,000^{ft}$, Febr. 1890, J. D. S., no. 1,909.

Trichilia Heydeana C. DC. — Foliis modice petiolatis 3–4-jugis, foliolis subæqualibus brevissime petiolulatis lanceolato-oblongis basi æquali acutis apice obtuse cuspidatis supra puberulis subtus dense molliter fulvescente-pubescentibus paniculis quam folia multum brevioribus dense pubescentibus, fere a basi ramosis, floribus breviter pedicellatis, calyce extus dense pubescente profunde acute 5-dentato, petalis 5 extus pubescentibus lanceolatis, staminibus inferne in tubum brevem glabrum cum disco connatum coalitis sursum laciniosis laciniis apice obtusis utrinque et intus densius hirsutis, antheris hirtellis avatis apice acutis, ovario disco lato supra villoso insidente villose 3-loculari.—Arbor 10–12^{m} alta. Ramuli juniores adpresse fulvescente-hirsuti, dein glabri in sicco fuscescentes lenticellis concoloribus. Limbi ad 12^{cm} longi ad 4.5^{cm} lati in sicco subcoriacei opaci crebre pellucido-punctulati, nervis secundariis utrinque circiter 12 patule subadscendentibus.

Petioli ad 2^{mm} longi. Rhachis cum petiolo 3^{cm} longo teres dense fulvescente-hirsuta. Paniculæ rami ad 7^{cm} longi fere a medio brevissime ramulosi, ramulis apice dense cymuligeris. Florum pedicelli 1^{mm} parum superantes. Alabastra subglobosa. Calycis dentes lanceolati. Petala circiter 2^{mm} longa in æstivatione imbricata. Antheræ 10 lacinias subæquantes.—Species *T. Wawranæ* C. DC. et *T. Glaziovii* C. DC. affinis.—Naranjo, Depart. Escuintla, alt. 300^{ft}, March 1892, J. D. S., no. 2,574; Rio Esclavos, Depart. S. Rosa, alt. $3,000^{ft}$, May 1892, Heyde & Lux, no. 3,274; S. Rosa, alt. $3,000^{ft}$, May 1892, Heyde & Lux, no. 3,275.

Cedrela impari-pinnata C. DC. —Foliis longe petiolatis impari-pinnatis 3–5-jugis, foliolis lanceolatis basi æquali acutis apice acute acuminatis subæqualibus utrinque puberulis lateralibus oppositis subsessilibus rhachi puberula, capsula oblonga glabra 4-valvata seminibus elliptico-oblongis.—Ramuli juniores puberuli dein glabri læves in sicco fuscescentes, cortice tenui. Folia cum impari ad 34^{cm} longa. Foliola in sicco membranacea subpellucida subtiliter pellucido-punctulata ad 8^{cm} longa ad 3^{cm} lata, nervis secundariis subpatulis utrinque circiter 12. Capsula circiter 5^{cm} longa valvis lanceolatis medio circiter 12^{mm} latio. Semen cum ala 3^{cm} longum, ala tenuissima. Species foliis impari-pinnatis insignis, *C. Vellozianæ* Rœm. quoad foliorum formam affinis.—Volcan de Fuego, alt. $6,000^{ft}$, March 1892, J. D. S., no. 2,571.

Oreopanax Taubertianum.—Primordial leaves broadly triangular; petioles robust, base abruptly broadly dilated and amplexicaul; leaflets digitately 5–9, chiefly 7, obovate-elliptical ($6–9 \times 2–3^{in}$), acutely acuminate, tapering to petiolule, coarsely and sharply toothed above middle, membranaceous, upper surface furfuraceous or glabrate, the lower stellate-pubescent, areolation minute and pellucid-punctulate: staminate racemes elongated ($16–24^{in}$), curving; pedicels pubescent, crowded, slender, thrice exceeding small (3^{l}) globose heads; petals 4–5, shorter than filaments, twice longer than single style; bracteoles surpassing ovary by their pubescent tips, the subtending one narrowly obovate; abortive ovary shortly obpyramidate: fruiting racemes somewhat shorter, pedicels longer (9-15^{l}), heads 5–12-baccate; berries ovoid, crowned with 5 semiconnate styles, by abortion 2–5-celled and with as many or fewer nucules, albumen ruminate.—Compared in the Berlin Herbarium by Dr. Taubert with specimens, authenticated by M. Marchal, of *O. Xalapense* Dcne et Planch. The only other species described with digitate leaflets, *O. Thibautii* Hook. f., is reduced by M. Marchal to a form of *O. Xalapense* (cf. Bull. Soc. Roy. Bot. Belg. **30**: 282).—A tree 30–40^{ft} high with branchlets half-encircled by the scars of fallen leaves, known to the natives as *Mata-gente.*—Barranca de Corona, Depart. Guatemala, alt. 4,700^{ft}, Febr. 1890 and 1892, J. D. S., nos. 1,905 and 2,664; S. Rosa, alt. 4,000^{ft}, March 1892, Heyde & Lux, no. 3,096; Chiapas, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,967.

Ardisia paschalis.—Glabrous: leaves obovate or elliptical (6–7.5 × 3–3.5^{in}), obtuse, narrowing to short canaliculate marginate petiole, entire, coriaceous, nitid, rubro-punctate and -striolate: panicle terminal, exceeding leaves; flowers racemose on primary branches, single, 5-merous, rubro-maculate, pedicels longer and in fruit nodding: divisions of calyx convolute, round-ovate (1.5^{l}): corolla in præfloration dextrorsely contorted, yellowish-white, the conspicous stellate centre thickened by dark-yellow pigment-cells, tube minute (half a line) and equalling explanate throat, obtuse segments oblong (4^{l}) and revolute: stamens slightly monadelphous at apex of tube; anthers ovoid-oblong (2^{l}), twice exceeding filaments, apiculate, before anthesis cohering in a cone by longitudinal sutures of of dehiscence: ovary ovoid, style filiform: fruit pisiform (3–4^{l}), endocarp crustaceous.—A shrub 6–9^{ft} high, with fragrant and showy flowers that are singularly large for the genus, called by the natives *Chilil*, and used during Easter week for decorating the altars of the churches.—Cuyotenango, Depart. Suchitepequez, alt. 1,100^{ft}, April 1892, J. D. S., no. 2,465; S. Rosa, alt. 3,000^{ft}, May 1892, Heyde & Lux, no. 3,023; Cerro Gordo, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,988; Casillas, Depart. S. Rosa, alt. 4,000^{ft}, May 1893, Heyde & Lux, no. 4,537. Collected also along Rio Permejo, S. Pedro Sula, Honduras, July 1887, by Dr. C. Thieme.

Explanation of Plate I.—Fig. 1, branch with flowers. Fig. 2, branch with fruit. Fig. 3, portion of leaf. Fig. 4, flower-bud. Fig. 5, open flower. Fig. 6, stamens. Fig. 7, pistil. Fig. 8, half of a corolla with stamens. Fig. 9, vertical section of fruit. (Figs. 1 and 2 are natural size; in the others the objects are variously enlarged.)

Piper Luxii C. DC. (§ III. Steffensia C. DC.)—Foliis modice petiolatis eliiptico-lanceolatis basi inæquali acutis supra præsertim ad nervos subtusque densius breviter hirsutis, nervo centrali vix ad $\frac{1}{2}$ longitudinis suæ nervos adscendentes utrinque 5 mittente, petiolo hirsuto basi vaginante, pedunculo quam petiolus breviore, amento ipso per anthesin limbi dimidium vix æquante apice mucronato, bractea obovato-oblonga apice rotundata utrinque dense villosa, filamentis elongatis antheris ellipticis quam filamenta pluries brevioribus, ovario conico parce piloso apice in stylum circiter eo æquilongum glabrum attenuato, stigmatibus linearibus recurvis.—Ramuli juniores dense villosi dein subglabrati, in sicco nigrescentes læves, amentiferi circiter 2^{mm} crassi, collenchymate in cortice continuo zona fibrosa continua intus aucto, fasciculis intramedularibus uniseriatis. Limbi in sicco membranacei nigrescentes pellucido-punctulati ad 20^{cm} longi ad 9^{cm} lati, juniores læves dein supra subbullati. Petiolus ad limbi latus longius circiter 2^{cm} longus. Amentum per anthesin circiter 6^{mm} crassum. Stamina 4 filamentis longis exsertis. Stigmata 3.—Species *P. Irazuani* C. DC. proxima, ab eo nervorum numero bractea apice obtusa ac longius densiusque pubescente et antheris oblongis discrepans.—San Miguel Uspantán, Depart. Quiché, alt. $6,000^{ft}$, April 1892, Heyde & Lux, no. 3,462.

Piper Uspantanense C. DC.—Foliis breviter petiolatis elliptico-lanceolatis basi parum inæquali utrinque acutis apice longe acute acuminatis supra glabris subtus ad nervos nervulosque adpresse hirtellis nervo centrali circiter mediumusque nervos utrinque 4 alternos adscendentes nervulosque validos mittente, petiolo basi ima vaginante dorso hirtello, pedunculo quam petiolus circiter $\frac{1}{3}$ longiore puberulo, amento ipso limbi dimidium vix æquante apice mucronulato, bracteæ pelta triangulari margine dense et longiuscule hirsuta pedicello extus piloso, antheris subglobosis quam filamenta brevioribus, ovario glabro, bacca glabra.—Suffrutex $1-1.5^{m}$ altus, ramulis junioribus hirtellis dein glabris punctulis albis conspersis, 2.5^{mm} crassis in sicco teretibus, collenchymate in cortice subcontinuo zonaque fibrosa discontinua intus aucto, fasciculis intramedullaribus uniseriatis. Limbi in sicco membranacei obscure virescentes subopaci creberrime pellucido-punctati ad 20^{cm} longi. Amenta nondum matura 2^{mm} crassa. Stamina 4 connectivo supra loculos brevissime producto. Bacca tetragona stylo destituta vertice in sicco rufescens. Stigmata 3.—San Miguel Uspantán, alt. $8,000^{ft}$, April 1892, Heyde & Lux, no. 3,460; Cerro Gordo, Depart. S. Rosa, alt. $3,500^{ft}$, Sept. 1892, Heyde & Lux, no. 3,827.

Piper Yzabalanum C. DC. in Donnell Smith Enum. Pl. Guat. pars II.—Foliis longiuscule petiolatis ample ovatis basi inæquali cordulatis apice breviter acute acuminatis utrinque glabris, nervo centrali paulo ultra medium nervos utrinque 7 patule adscendentes mittente, petiolo glabro limbum usque vaginante, pedunculo quam petiolus adultus 4-plo breviore glabro, amento quam folium pluries breviore apice breviter mucronato, bracteæ spathulatæ vertice inflexo triangulari glabro pedicello lato basi inter baccas producto et hirtello, bacca glabra vertice pulposa.—Ramuli glabri punctulis albis notati in sicco complanati 4–5^{mm} crassi, fasciculis collenchymatosis in cortice distinctis intus fibris aliquot auctis, fasciculis intramedullaribus uniseriatis. Limbi 18^{cm} longi circiter 12^{cm} lati in sicco membranacei pellucido-punctulati. Petioli circiter 4^{cm} longi. Amenta matura ad 6.5^{cm} longa 5^{mm} crassa. Baccæ subtetragonæ stylo destitutæ vertex pulposus in sicco ambitu subproductus. Stamina 4. Stigmata 3.—Boca del Polochic, Depart. Yzabal, alt. 200^{ft}, April 1889, J. D. S., no. 1,712.

Piper Heydei C. DC. (§V. POTOMORPHE C. DC.)—Foliis longe petiolatis adultis $\frac{1}{3}$ supra limbi basin peltatis ovato-rotundatis amplis basi rotundatis repando-subcordatis apice breviter acute acuminatis supra glabris subtus præsertim ad nervos nervulosque fulvescenti-hirsutis 14-plinerviis nervo centrali nervos adscendentes utrinque 3 supra limbi basin et ad $\frac{1}{4}$ longitudinis mittente cæteris nervis e petiolo divaricantibus, petiolo medium usque vaginante dorso apicem versus parce hirsuto, amentis apice ramuli sat longi glabri circiter 12-umbellatis longiuscule pedunculatis ipsis florentibus quam foliorum limbi pluries brevioribus, bracteæ pelta triangulari margine fulvescente hirsuta, antheris subglobosis, ovario glabro.—2^{m} altum. Folia juvenilia haud peltata basi cordata. Limbi in sicco firmule membranacei subopaci pellucido-punctati 33^{cm} longi medioque lati. Petioli adulti circiter 16^{cm} longi. Ramuli amentiferi glabri verisimiliter axillares 16^{cm} longi. Amentorum pedunculi 5^{cm} longi. Amenta ipsa adhuc juvenilia inæquilonga ad 9^{cm} longa. Stamina 3 quorum 2 lateralia tertium posticum. Antheræ filamentis circiter æquilongæ. Ovarium ovatum apice attenuatum adhuc juvenile.—Species limbis subtus hirsutis, ramulis amentiferis multo longioribus et præsertim floribus 3-staminalibus a *P. peltato* L. valde discrepans.—San Miguel Uspantán, alt. 7,000^{ft}, April 1892, Heyde & Lux, no. 3,461.

PIPER TUBERCULATUM Jacq. ic. rar., var. δ. **obtusifolium** C. DC.—Foliis apice rotundatis cæterum ut in specie.—Frutex 3^{m} altus.—Rio Ocosito, Depart. Quezaltenango, alt. 250^{ft}, April 1892, J. D. S., no. 2,592; S. Rosa, alt. $3,000^{ft}$, June 1892, Heyde & Lux, no. 3,464. Collected also near Grenada, Nicaragua, by Lévy, no. 93.

Peperomia macrophylla C. DC. — Foliis petiolatis anguste lanceolato-oblongis basi in petiolum decurrentibus apice acute acuminatis utrinque glabris pellucido-punctulatis penninerviis, nervo centrali fere a tota longitudine nervos adscendentes utrinque circiter 10 mittente, amentis ad ramos axillares aphyllos quam folia parum breviores laxe circiter 5 paniculatim dispositis ipsis breviter pedunculatis folii dimidium vix æquantibus, bractea suborbiculari centro brevissime pedicellata, ovario apice oblique scutatim complanato scutello elliptico apice obtuso in medio stigma carnulosum gerente, bacca anguste cylindrica patenti glabra apice scutello persistente erecto subacute terminata.—Herba glabra caule basi decumbente e nodis radicante superne suberecta. Folia alterna. Limbi ad 20^{cm} longi et ad 3.5^{cm} lati in sicco membranacei subpellucidi basi in petiolum ad 3^{cm} longum angustati. Amenta matura in sicco 2^{mm} crassa, basi squamis lanceolatis deciduis fulta, inferiora 2 alterna superiora 2 opposita ultimum terminale. Pedunculi circiter 5^{mm} longi. Antheræ minutæ. Baccæ brevissime stipitatæ cum scutello 1.5^{mm} longæ.—Palin, Depart. Amatitlan, alt. $3,560^{ft}$, Feb. 1892, J. D. S., no. 2,578; Barranca de Eminencia, Depart. Amatitlan, alt. $1,400^{ft}$, Feb. 1892, J. D. S., no. 2,579.

Peperomia violæfolia C. DC. — Foliis longe petiolatis e basi cordata inferioribus rotundatis superioribus ovatis apice acute acuminatis utrinque glabris 7–9-nerviis, amentis oppositifoliis sublaxifloris breviter pedunculatis glabris foliorum limbos parum superantibus, bractea orbiculari centro pedicellata, ovario emerso stipitato obovato-elliptico apice imo stigma minutum carnulosum gerente, bacca elliptica breviter stipitata. —Herba glabra e stolone caules multos circiter 10^{cm} altos in sicco membranaceos ad 3^{mm} crassos dense agens. Folia alterna. Limbi in sicco tenuiter membranacei pellucidi haud crebre pellucido-punctati 6–7^{cm} longi 5–6.5^{cm} lati. Petioli ad 7^{cm} longi. Pedunculi circiter 1^{cm} longi. Amentia florentia in sicco membranacea pellucida 1.5^{mm} crassa. Ovarium stipite suo parum breviore. Bacca stipitem suum pluries superans circiter ad 1^{mm} longa. Palin, alt. $3,500^{ft}$, Feb. 1892, J. D. S., no. 2,580.

Peperomia Sisiana C. DC.—Foliis modice petiolatis oblongo-lanceolatis basi acutis apice longiuscule anguste et subfalcatim acuminatis utrinque glabris junioribus margine ciliolatis 7-plinerviis nervis lateralibus utrinque 2 e basi uno ex $\frac{1}{4}$ longitudinis supra basin solutis, petiolo juniore parce hirtello, amentis adultis folia duplo superantibus filiformibus glabris densifloris, bractea orbiculari centro subsessile, ovario emerso apice scutatim aucto, scutello in medio stigmatifero apice acuminato, stigmate minuto, bacca emersa patente cylindrica apice oblique rostellata.—Herba e basi radicante ramulos circiter 25^{cm} longos erectos apice parce hirtellos inferne glabros agens. Folia alterna. Limbi in sicco membranacei subpellucidi ad 9^{cm} longi et 3–3.5^{cm} lati. Petioli ad 1^{cm} longi. Amenta matura vix 2^{mm} crassa. Baccæ 1.5^{mm} longæ.—Species *P. Naranjoanæ* C. DC. proxima, forsan eadem cum amentis maturis longioribus, limbis basi acutis a *P. elongata* Kunth differt sed ejus quoque proxima.—Rio Sis, Depart. Suchitepequez, alt. $1,300^{ft}$, April 1892, J. D. S., no. 2,584.

Peperomia San-Felipensis C. DC. —Foliis breviter petiolatis anguste lanceolatis basi et apice acutis utrinque glabris et nigro-pynctulatis 5-nerviis, amentis terminalibus axillaribusque breviter pedunculatis glabris nigro-punctulatis subdensifloris ipsis folia circiter duplo superantibus, bractea orbiculari centro subsessili, ovario emerso sub apice oblique stigmatifero, bacca subglobosa glabra.—Herba repens glabra caulibus in sicco 1.5^{mm} crassis. Folia alterna. Limbi in sicco firmulo-membranacei subpellucidi 3–4^{cm} longi 8–10^{mm} lati nervis subtilibus. Petioli 6^{mm} longi. Pedunculi vix 5^{mm} longi. Amenta 1^{mm} crassa. Species *P. glabellæ* Sw. proxima limbis angustioribus nervorum numero ramulisque glabris ab ea discrepans.—San Felipe, Depart. Retalhuleu, alt. $2,050^{ft}$, April 1892, J. D. S., no. 2,583.

Peperomia Heydei C. DC. —Foliis longissime petiolatis ovato-rotundatis basi cordatis apice rotundatis 9–11-nerviis utrinque glabris, amentis terminalibus axillaribusque glabris longe pedunculatis foliorum limbos circiter æquantibus, floribus annulatim dispositis, bractea orbiculari, ovario obovato apice oblique complanato oblique stigmatifero.—Herba glabra caule decumbente basi radicante in sicco tenuiter membranacea pellucida. Folia alterna. Limbi adulti ad 13^{cm} longi cum petiolis ad 20^{cm} longis in sicco tenuiter membranacei pellucidi. Pedunculi circiter 4^{cm} longi. Amenta in sicco membranacea

2^{mm} crassa. Bractea ovariumque glandulis pallidis conspersa.—Species *P. Gardneriana* Miq. affinis.—Laguna de Ayarza, Depart. Jalapa, alt. $8,000^{ft}$, Sept. 1892, Heyde & Lux, no. 3,834.

Var. *β*. **minor** C. DC.—Foliis minoribus, limbis ad 9^{cm} longis in sicco paulo firmioribus, petiolis ad 6^{cm} longis, amentis foliorum limbos superantibus.—Estanzuela, Depart. S. Rosa, alt. $2,500^{ft}$, Aug. 1892, Heyde & Lux, no. 3,835.

Peperomia Guatemalensis C. DC.—Foliis breviter petiolatis subrhombeo-lanceolatis basi cuneatis apice obtusiusculis supra glabris subtus pilosulis 5-nerviis nervis externis subtilibus, amentis terminalibus vel axillaribus pedunculatis glabris folia pluries superantibus densifloris, bractea elliptica paulo supra medium peltata subsessili, ovario rhachi impresso obovato apice oblique stigmatifero, bacca globosa glabra.—Herba erecta circiter 12^{cm} alta inter muscos crescens, caulibus pilosulis inferne radicantibus. Folia inferiora opposita superiora alterna. Limbi in sicco membranacei subopaci pellucido-punctulati $3–5^{cm}$ longi $1.5–2^{cm}$ lati. Petioli ad 4^{mm} longi. Pedunculi ad 8^{mm} longi. Amenta glabra ipsa matura circiter 10^{cm} longa in sicco 1.5^{mm} crassa.—Species *P. Bauerianæ* Miq. proxima.—Acatepeque, alt. $4,300^{ft}$, March 1892, J. D. S., no. 2,587.

Peperomia Santa-rosana C. DC.—Foliis quaternis brevissime petiolatis e basi cuneata obovatis apice emarginatis utrinque glabris 5-nerviis, amentis terminalibus pedunculatis ipsis adultis folia pluries superantibus glabris, bractea orbiculari subsessili, ovario emerso in apice obtuso oblique stigmatifero, stigmate minuto.—Herba erecta glabra. Caules in sicco complanati, amentiferi circiter 2^{mm} crassi, steriles ad 6^{mm} crassi. Limbi caulium fertilium 2^{cm} longi 13^{mm} lati, sterilium ad 3^{cm} longi et ad 15^{mm} lati. Petioli $2–3^{mm}$ longi. Pedunculi ad 2^{cm} longi. Amenta florentia ad 13^{cm} longa et ad 2^{mm} lata.—*P. obcordatæ* Presl verisimiliter proxima sed foliis majoribus et minus profunde emarginatis ab ea discrepans.—S. Rosa, alt. $3,000^{ft}$, June 1892, Heyde & Lux, no. 3,454.

Pilea Pansamalana.—Suffrutescent ($1.5–2^{ft}$); branches several from base, decumbent, simple, terete: stipules minutely triangular; leaves glabrous, punctate and lineolate above, venose beneath, subopposite nerves remote from base and vanishing below apex, crenate-serrate except at base, dimorphous and very unequal in the pair; the larger lanceolate to rhomboid-elliptical ($18–36 \times 6–10^{l}$), tapering each way from middle, apex obtuse, base acutely narrowed into short ($2–3^{l}$) petiole; the smaller obovate or rhomboid-orbicular, apex rounded, base acute, petiolate: diœcious; pistillate cymes (the only seen) not exceeding petiole of larger leaves, pedunculate, divaricate, flowers pedicellate, interior segment of perianth subequalling the others and minutely cucullate, twice exceeded by staminodes, half as long as obliquely oval (0.75^{l}) and pubescent achenium.—Nearest to *P. dendrophila* Miq.—On decayed mossy trunks of trees, Pansamalá forest, Depart. Alta Verapaz, alt. $3,800^{ft}$, June 1886, von Türckheim, no. 939.

Pilea riparia. — Stem repent, elongate, ligneous, simple branches ascending ($6–12^{in}$): stipules minute, deltoid; leaves glabrous, thick, subentire, 3-nerved from base to middle on upper surface and nearly to apex on reticulated lower surface; the larger in the pair oblong-elliptical ($3.5–4 \times 1.75^{in}$), long-acuminate, tapering gradually to short ($2–4^{l}$) petiole; the other a fourth smaller, obovate-elliptical, abruptly acuminate; cystoliths of upper surface densely stellulate-punctiform, of lower minutely linear, of margins large and fusiform: diœcious; staminate cymes not seen; the pistillate pedunculate, little exceeding petiole, divaricate, interior segment of perianth lightly gibbous on back and scarcely exceeding the others, staminodes as long, oval achenium thrice longer (0.5^{l}) and smooth.—Nearest to *P. marginata* Wedd.—Specimens of this, as well as also of the other proposed new species except *P. irrorata*, have been compared by Dr. Taubert in the Berlin Herbarium. I am likewise indebted to him for the identification of several other *Pileæ*, difficult of determination without the aid of authenticated material.—On rocks in a stream, Pansamalá, alt. $3,800^{ft}$, August 1886, von Türckheim, no. 1,040.

Pilea irrorata. — Herbaceous; stem shortly rooting at base, stout, simple or forked ($1–2^{ft}$): stipules elongate-triangular ($2–3^{l}$), persistent; petioles long ($1.5–3.5^{in}$), canaliculate, dilated at base and apex; leaves membranaceous, smooth, ample ($6–9 \times 2–4^{in}$), elliptical, caudate-acuminate, obtuse, base acuminate, the opposite uniform and nearly equal, sinuate-serrulate above middle, 3-nerved from insertion to apex, transverse veins distinct and subparallel, above punctulate and toward base lineolate, cystoliths scarcely present beneath:

monœcious or diœcious; cymes unisexual, subsessile, bracteose, densely flowered; the staminate semi-globose (5–8^{1} high), axes explanate, fascicled pedicels filiform (3^{1}), perianth before anthesis obpyramidate (0.75^{1}) with inflexed cucullate tips, rudimentary ovary nearly obsolete; pistillate cymes smaller and glomeruliform, staminodes most minute, exterior segments of perianth small.—Distinguished chiefly by the long pedicels of staminate flowers.—Pendent from irrigated cliffs of the Barranca of Rio Samalá, Depart. Retalhuleu, alt. $1,700^{ft}$, April 1892, J. D. S., no. 2,751.

Pilea pleuroneura. — Rooting at woody base, ascending (12–18^{in}), branching composite, branchlets complanate and alate, glabrous, glandulose: stipules minutely semi-obicular; leaves distichous, subsessile, lanceolate (7–9 × 1.5–2^{1}), the smaller in the pair half as long and elliptical, apex obtuse, 2–5-crenate, the inferior half entire and cuneate, penninerved, the stronger 7–9 nerves ascending to margin, veins immersed, cystoliths present only on upper surface and linear: diœcious; staminate flowers not seen; the pistillate fasciculate at apex of longer (1–1.5^{1}) peduncle, short pedicels recurved, cucullate segment of perianth twice exceeding the others, achenium obliquely ovate (0.5^{1}) and rubro-punctate.—Pansamalá, alt. $3,800^{ft}$, June 1885, von Türckheim, no. 754.

Pilea senarifolia. — Herbaceous, glabrous; stem repent, branches ascending (12–18^{in}), opposite or verticillate branchlets 6-alate: stipules scarious, minutely oblong, persistent; petioles short (0.5–1^{1}), induplicate; leaves 6-verticillate, unequal, obovate-spatulate to obovate-cuneate (3–5 × 1.5–2^{1}), coarsely incurved-crenate above middle, penninerved, crenations and nerves three to a side, upper surface transversely striolate with fusiform cystoliths: monœcious; unisexual cymes from adjacent axils in the whorl; the staminate twice to thrice exceeding petiole, 2–3-flowered, peduncle and pedicels subequal, perianth in præfloration globose (1^{1}), tips of segments pileate, rudimentary ovary none; pistillate cymes minute, few-flowered, segments of perianth somewhat unequal.—Anomalous by leaves all strictly verticillate.—On old trunks of trees, Chiul, Depart. Quiché, alt. $8,000^{ft}$, April 1892, Heyde & Lux, no. 3,145.

Pilea Quichensis. — Herbaceous; stem simple (20–30^{in}), slightly pubescent, sulcate: stipules deltoid (1.5^{1}), deciduous; petioles slender ($1-2^{in}$), triquetrous by produced nerves of leaf, estriolate; leaves glabrate, the opposite somewhat unequal, obliquely oblong-elliptical ($4-6.5 \times 1-2^{in}$), prolonged to a slender ($6-9^{l}$) and sharply serrate tip, base acute and induplicate, serrate throughout, 3-nerved to apex, exterior veins all equal and ascending to margin of incurved crenations, interior veins anastomosing, veinlets finely reticulating, pellucid, upper surface striate with small cystoliths, the lower glaucous: monœcious; staminate cymes geminate, shorter than petiole ($5-8^{l}$), peduncle bifurcate, flowers single and racemose or few-clustered on long spreading branches; perianth in aestivation oval (1^{l}) and exceeding pedicel, obtuse segments incrassate at the base and back, stamens twice longer, rudimentary ovary minutely subulate; pistillate cymes from uppermost axils much smaller, in anthesis conglomerate, broadly cucullate segment of perianth thickened and exceeding the scarious exterior ones, ovary slenderly elliptical.—Intermediate between *P. multiflora* Wedd. and *P. falcata* Liebm.—San Miguel Uspantán, alt. $6,500^{ft}$, April 1892, Heyde & Lux, no. 3,147.

PINUS DONNELL-SMITHII Mast., Botan. Gaz. **16:** 199.

EXPLANATION OF PLATE II.—Fig. 1, portion of branch with leaf-scars, tufts of leaves, primordial leaves and male flowers, nat. size.—Fig. 2, tuft of leaves with sheath of leaf-scales at the base.—Fig. 3, portion of leaf magn. 4 times, showing lines of stomata and serrations at the edge.—Fig. 3^{a}, section of leaf magn. 50 diam., showing epiderm, two layers of hypo- or exoderm, stomata, mesophyll with sinuous cells, a triangular pericycle with well marked endoderm and a branched fibro-vascular bundle with phloem towards the dorsal side of the leaf and xylem towards the upper edge. Between the two masses of xylem are several large libriform cells.—Fig. 4, primordial leaf or "*squama fulcrans*" magn. 4 diam.—Fig. 5, male flower isolated magn. 2 diam.—Fig. 6, stamen from the front and from the back magn. 6 diam.—Fig. 7, stamen from the side magn. 6 diam.—Fig. 8, pollen grain magn. 200 diam.—Fig. 9, ripe cone.—Fig. 10, longitudinal median section of cone.—Fig. 11, detached scale of cone showing apophysis and umbo.—Fig. 12, scale of cone seen from the side.—Fig. 13, young seed.

Dioscorea dicranandra. (§ ALLACTOSTEMON Griseb. in Fl. Bras.)—Glabrous in all parts: leaves orbicular-cordate ($5-9 \times 4-7^{in}$), abruptly acuminate, membranaceous, pale beneath, pellucid-lineolate, nerves 7–9, the exterior pair 1-furcate, midrib somewhat exceeding stout petiole and thrice longer than approximate basal lobes, sinus broad, transverse veins distinct: spikes solitary, or the fertile 3–5-fasciculate and occasionally furcate, filiform ($12-17^{in}$), rachis angulate, bracts broadly oval and long-acuminate, flowers solitary and sessile;

sterile flowers somewhat exceeding bract, perianth $\frac{3}{4}$-partite, semi-erect segments oblong-lanceolate (1.5^1), distinct stamens a third as long and exceeded by subulate staminodes, anthers bipartite-locular and shorter than filament, rudimentary ovary none; fertile flowers less approximate, segments of perianth linear (1.5^1) and equalling tube and bract, connate styles very short (0.5^1) and twice exceeding effete stamens, deflected stigmas bilabiate: capsules not seen.—The character is drawn from specimens collected at two localities and respectively of different sexes, but matching in form and anatomy of foliage; in each the flowers are of novel structure.—Cerro Gordo, Depart. S. Rosa, alt. 3,500^{ft}, Sept. 1892, Heyde & Lux, no. 3,869; Rinconcito, Depart. S. Rosa, alt. 4,000^{ft}, Nov. 1892, Heyde & Lux, no. 4,359.

Baltimore, Md.

On the color description of flowers.

J. H. PILLSBURY.

In no respect is the description of a plant more often doubtful than in the color assigned to the flowers, especially if any trace of violet be present in the coloring. It is not at all uncommon to hear some one, reading the description of a flower, exclaim regarding the color, "that is wrong." During the past ten years I have noted with much interest the different expressions used by students in my classes to describe the color of some of our most common wild flowers. As a rule, I have found that young ladies are much more explicit in their description of the color of a flower than the young men of equal intellectual advancement. This is probably not due to a keener color sense, but to the possession of a fuller vocabulary of color terms. In consequence of this fuller vocabulary, the young lady seeks to express smaller differences of color. I have not found, however, that she is more accurate in her description of the color in question. Indeed, it has often seemed to me that the smaller vocabulary has led to a more careful discrimination and a more correct discernment of the components of the color. What we most need is not a fuller vocabulary but a more accurate use of the vocabulary we now possess. It is no doubt a fact that an occasional source of confusion in the description of floral color is a more or less feeble sense in regard to some one color. But this difficulty can not be of sufficiently frequent occurrence to be a serious source of confusion. The percentage of persons who are either color blind or possess only a feeble sense for some one color is so small that there is certainly likely to arise no very frequent trouble from such a source.

The confusion of color description arises mainly from two clearly discernible sources both of which, it seems to me, we may reasonably hope to be able to remove.

The first of these sources needs hardly more than the mere mention to be recognized by every botanist. I refer to the fact that we have absolutely no recognized standards of color, and no generally accepted plan of color nomenclature. To say nothing of the conflicting theories of color which are still in vogue, each of which has its adherents, nearly every writer on color, who has made the least attempt to suggest a scheme of colors to be used as a basis of color work, has proposed at least one color which is peculiar to himself, either in name or in quality; and in only a few instances has any exact definition been suggested even for a single color. Where one writer has used the term red to designate a primary color, another has used the term vermillion. The former term, without any limitations, will include a variety of hues; and the latter is by no means as definite as might be supposed, since pigments called vermillion by different manufacturers vary greatly in hue. In the few cases in which a particular color term has been proposed and designated by some such definite limitations as the wave length of its vibrations, it has been only for single colors. No series of colors has been proposed as standards upon which a scheme of nomenclature might be based. The result has been the same as before. No remedy for the confusion that prevails is offered.

The second source of confusion is in part dependent upon the first and yet is a very distinct source of trouble. It is the lack of correct color education and ability to correctly analyze color impressions. It has been maintained that the eye does not analyze color impressions. In a sense this is undoubtedly true; but there is also a sense in which it is true that the eye does analyze color. When we look at any patch of color which is not one of the pure spectrum hues, the eye does not see the two colors which would produce that color impression. What we do see is the result of a very complex mixture of light waves of a great variety of wave lengths impinging upon the retina, and the impression is generally due to a preponderance of waves of a rate lying between those of some two well defined colors. Perhaps this can be made clearer if we take an illustration from musical sounds. Suppose the ear to detect a sound having a pitch somewhere between C and D. Now, although the ear does not hear either C or D in that sound, it may be able to determine that the sound lies somewhere between C and D in pitch, and that it lies nearer C than D. Just this same sort of discrimination we need to have taught with regard to color, and especially with regard to the color of flowers. When once we have agreed upon a series of standards of color, this education will be not only possible but easy. With a reasonable amount of training it will not be found difficult to locate any color between two colors of the solar spectrum.

It was these difficulties to which I have above referred in the use of color terms, and certain anomalies which I encountered in the course of a series of physiological investigations regarding color sense, which led me to give my attention to the selection of a system of color standards taken from the solar spectrum, the only source of authority in color. (See *Science* for June 9th, 1893.)

With these standards to work from, I undertook to determine the color analysis of certain of our common flowers. The following results will, I think, be interesting to botanists. The numbers given indicate per cent. of color required to produce the hue of the flower.

The symbols used in the formula stand for the six spectrum colors, viz., red, orange, yellow, green, blue and violet with white and black (N for *niger* being used to avoid the repetition of B).

Common forsythia, F. viridissima: pure spectrum yellow.
Fringed polygala, P. paucifolia: R 48, V 52.
Wistaria, W. frutescens, wings: R 11, V 89.
" " " , standard: R 9, V 79, W 12.
Flowering quince, Cydonia japonica: R 95, V 2, W 3.
Wild cranesbill, Geranium maculatum: R 28, V 66, W 6.

The variations of color in the early summer foliage is also interesting. The following analyses are for the upper side of fresh and well developed healthy leaves. It is not impossible that a little attention to these variations in the color of foliage on the part of artists would save us the annoyance of some of the abominable green which we so often see in the pictures of artists of good reputation.

White oak: Y 7.5, G 11.5, N 81.
Apple: Y 5, G 13, W 2, N 80.
Copper beech: R 17, V 2, N 81.
Hemlock: Y 2, G 9, N 89.
White pine: Y 2.5, G 11, N 86.5.
White birch: Y 5.5, G 11.5, W 1, N 82.
Hornbeam: Y 5.5, G 12.5, N 82.
Shagbark hickory: Y 4.5, G 9.5, N 86.

These analyses were made in a moderately strong diffused light with Maxwell discs of the standard hues referred to above. The discs were combined upon a color wheel giving sufficiently rapid rotation to blend the colors smoothly and give an even surface of color with which to compare the flower or leaf as the case might be. The analyses can be easily made by any one and after a little practice with a good degree of accuracy. The objects to be gained by such analyses are twofold, viz., the determination of floral color with something like accuracy and the development of a keener perception of color relations. Discs in these standard hues can be obtained at a moderate price and they can be used on any apparatus for rotating the Maxwell discs.

It has already been intimated that greater confusion prevails with regard to violet than any other color. By some writers purple has been used to designate the most refrangable color of the solar spectrum. This is very unfortunate and has led to a great many errors that are exceedingly difficult of correction at the present time. All of the numerous hues to which the term purple is properly applied are combinations of red and violet, often modified by the presence of some white light and almost always with more or less of black, thus forming what is called a broken purple. In the above analyses we have in the fringed polygala the red and violet in nearly equal proportions. The color of the flowering quince is slightlyviolet red modified by the presence of a small portion of white, On the other hand the color of the wistaria is a reddish violet, in the wings modified by white in the standard. The cranesbill is a still more red violet, i. e., it comes nearer to a purple.

The colors assigned to the flowers whose analysis I have given above in two of the botanical text books most commonly used in our schools are as follows: under the description of Polygala paucifolia Wood says, "flower purple" while Gray says, "flower rose purple." Concerning the wistaria both Wood and Gray say, "flower lilac purple." Wood describes the flower of Cydonia Japonica as "crimson." Gray gives the color of Geranium maculatum as "light purple" while Wood calls the same flower simply "purple."

Springfield, Mass.

Archenema, protonema and metanema.

CONWAY MACMILLAN.

It is intended in this brief paper to call attention to certain gametophytic differentiations and possible homologies which, while not by any means everywhere overlooked, have not, perhaps, received the proper accentuation in current botanical thought. At the outset it may be well to attempt to give a definition of a gametophyte. As understood by the writer, this term does not by any means properly apply to every plant structure that produces gametes. The Cœloblasteæ, for example, mature undoubted eggs and sperms, but the plant body thus functioning can scarcely be termed a gametophyte. A gametophyte can be defined only in terms of a sporophyte held in contradistinction with it. Therefore it is only in that group of plants that I have named the Sporophyta[1] that gametophytic structures may be rightly discerned. It is inadmissible to apply the term to any plant below the position of Œdogonium (or Ulothrix?). A gametophyte, then, is a structure derived directly or indirectly from a sporophytic spore or its analogue, and itself capable of producing, directly or indirectly, a gamete or gametes. The algæ Œdogonium and Coleochæte, "leafy moss plants," fern prothallia, the endosperm of Araucaria, the pollen tube of Burmannia and the embryo-sac nuclei of Narcissus are types of gametophytes. The definition, it will be observed, takes note both of formation and of function. In the case of each a reservation must be made, for gametophytes may arise directly by propagative methods, as in the breaking up of a moss protonema, or by the activity of certain bodies (the homologies of which may be with multiple spores rather than with propagative structures), such as the gemmæ of Aulacomnium and Lunularia. And on the other hand, through apogamy, as in *Todea africana*, *Pteris cretica* and a few other ferns, or in some less aberrant manner, the gametophytic structure may fail to produce gametes.

Thus defined, the gametophyte may be isolated for study in any species where it occurs. It should be noted, perhaps,

[1] Metaspermæ of the Minn. Valley 20. 1892.

at this point, that the interlocking and interdependence of sporophyte and gametophyte is such that, wherever they alternate, certain structures appear, under a rigid classification, to be included in both categories. The same cell may be morphologically sporophytic but physiologically gametophytic, or *vice versa.* This is true of the two unicellular stages which serve to distinguish so sharply the higher plants from the higher animals (in which there is but one unicellular stage in the life-history of the organism). The spore, since it is structurally part of the sporophyte, must be grouped by morphology with the other sporophytic structures. But, since the spore is also the first stage of the gametophyte which becomes elaborated through development, it must, by the classification of physiology, be grouped with the gametophyte. The same paradox is to be noted for the fecundated egg. It is quite as distinctly gametophytic from a morphological point of view, but in the physiological sense it is sporophytic.

A consideration of the gametophyte of the Muscineæ reveals to the student its comparatively high structural rank among gametophytes. This high rank is evidenced most particularly by its developing not as a continuous structure with but one developmental stage, but as a discontinuous structure with two distinct developmental stages. While gametophytes above and below the Muscineæ may be considered as generally monomorphic, the gametophyte of the Muscineæ is very constantly dimorphic. It appears in two readily separable stages of certainly deep phylogenetic meaning. The first of these stages is known as protonema. For the second I propose the term, *metanema.* The gametophyte of any hepatic or moss may then be considered as distinguishable into protonema and metanema. Protonemata may be compared with metanemata or with other protonemata, and conversely. An examination of protonemata from the point of view of comparative anatomy shows that they exhibit much power of evolution and improvement. Structurally either filamentous or thalloid, they exhibit much variety, and increase in size and complexity as one passes from the lower Hepaticæ to Hypnum and Bryum. Physiologically they show, in many of the true mosses, wider capacity than in the liverworts, this being particularly evidenced by increase of propagative power with perfecting of propagative apparatus. The protonemal tubers of *Barbula muralis* and *Trichostomum rigidum* are examples of this increase; and, of a quite different category, the remarkable formation of *protonemal chlamydospores* by *Funaria hygrometrica* should be mentioned.

Similarly one notes in metanemata much development in form and function, as the ascending series from Riccia and Anthoceros is followed. The metanema is, as has been conjectured, very probably a highly specialized gametophore which has assumed in connection with its particular reproductive functions many improvements in vegetative function with their attendant morphological developments. In such plants as Preissia or Conocephalus, where the metanema is differentiated into vegetative and reproductive branches, one sees a reiteration of the process by which the metanema was itself differentiated from the protonema.

The typical metanema of the Muscineæ undergoes a vegetative evolution in two directions. It appears either as thallus or as leafy stem. In the Muscineæ, as far as I know, there is no truly filamentous metanema. The male prothallium of Salvinia, and pollen tubes in general—if they be metanemata at all—would furnish examples of the filamentous type. It is perfectly apparent however that not all of the thalloid metanemata of the Muscineæ are of equal rank. The same is true of the leafy-stemmed metanemata. In the Hepaticæ, where both thalloid and leafy-stemmed metanemata are to be found, some thalli may be regarded as original while others may be considered as derived from leafy stems. Marchantia, for example, may, with much reasonableness, be derived from a Jungermannia archetype; while Anthoceros, on the other hand, may be derived directly from a Coleochæte-like archetype. The close genetic union of Marchantia with Riccia through Boschia and Corsinia, argued by Leitgeb[2] principally upon the basis of sporophytic homologies, is not perhaps to be considered as fully proved. If, on the contrary, Marchantieæ are to be considered rather as reduced Jungermannieæ, the Marchantia thallus may be defined as secondary. Thalli may therefore arise primarily by the evolution of protonemal branches or secondarily by the reduction of a leaf-bearing axis. The same suggestions apply to leafy-stemmed metanemata. They may, like Lejeunea, be considered as having arisen from thalli the margins of which have become dissected;

[2] Leitgeb, Die Marchantieen 49. 1881.

or they may arise directly from protonemal structures, as in Buxbaumia.[3]

One may then classify the metanemal structures of the Muscineæ thus:

Metanema of Muscineæ	Leafy stems	Secondary leafy stems.
		Primary leafy stems.
	Thalli	Secondary thalli.
		Primary thalli.

It is probable that neither in the Hepaticæ nor in the Musci is there any gametophyte that is not susceptible of division into protonema and metanema. It has been affirmed that Frullania, Anthoceros and a few other Hepaticæ develop directly from the spore as monomorphic structures (Nees ab Esenbeck), but this is not borne out by the researches of Leitgeb[4] who figures for Anthoceros at least a well-marked protonema. And for Frullania and its allies among the foliose Jungermannieæ, while Hofmeister believed that the protonema might be suppressed, the researches of Grönlund[5] have well demonstrated that the protonemal structure is constantly present in one form or another. Leitgeb himself concludes that the protonema is a normal stage for Frullania, Radula and the rest.[6]

Below the Hepaticæ there are undoubted gametophytes without any marked differentiation into protonema and metanema and others in which the differentiation is a matter of grave doubt. Of the first group, Œdogonium and Bulbochæte may be cited; of the second, Chara, Tolypella, Lychnothamnus and their allies. For the gametophytic structure that does not show any differentiation into protonema and metanema and stands lower than the hepatic gametophyte, I propose here the name of *archenema.* The Coleochæte thallus is an example of typical archenema. The gametophyte of the Characeæ is as certainly archenema upon the view that the so-called pro-embryo is an aposporous sporophyte.[7] If however the pro-embryo be taken for protonema and it be assumed that the sporophyte is altogether suppressed, then certainly the mature Chara plant must be classed as metanema.

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[3] Goebel, On the simplest form of moss. Ann of Bot. **6**:355. 1892.

[4] Leitgeb, Die Anthoceroteen. 20. *pl. 1.* 1879.

[5] Grönlund, Mem. sur la germination de quelques hépatiques. Ann. Sci. Nat. Bot. IV. **1**:

[6] Leitgeb, Die foliose Jungermannieen 63. 1875.

[7] Vines, The pro-embryo of Chara. Journ. of Bot. 1878.

Three structural categories of gametophytes have now been established in this discussion; archenema, protonema and metanema. The very important question then arises:—what are the homologies of the fern prothallium? It is apparent that there is no *á priori* reason why it may not be any one of the three. In Coleochæte the gametangia are borne upon archenema; in Buxbaumia at least the antheridia are produced upon protonema (Goebel), while in the great majority of Hepaticæ and Musci the gametangia are altogether metanemal in their origin. The fern prothallium might then be considered as a developed Coleochæte-like structure which has not passed through the differentiation into protonema and metanema; or it may be regarded as a thalloid protonema, the metanemal companion stage of which has been suppressed by reduction; or again as a metanema, the embryonal protonemal stage of which has disappeared. It will be seen at once that the correct interpretation of the facts in the case is of great importance. Especially, in view of the fact that there is a modern effort to reach the conclusions of fern phylogeny from the gametophytic as well as from the sporophytic side of the organism, is it imperative that the three possibilities be held distinctly in view. Indeed it would seem as if the criticism here undertaken might indicate the necessity for a revision of some important conclusions which have been put forth recently by students of the Archegoniatæ. For example, I am here strongly inclined to criticise the position maintained by Campbell[8] that "the prothallium of Hymenophyllum corresponds not merely to the protonema of a moss, but to the protonema *plus* the leafy plant." It is not that the position may not be a sound one (for the prothallium may indeed be archenema), but because the verdict should as yet be the Scotch verdict. And especially, in view of the very able and convincing argument of Campbell in favor of considering the eusporangiate ferns as basal and derived from the vicinity of Anthoceros with its undoubted metanema, must one hesitate to regard the prothallium of Hymenophyllum or any other fern as archenemal. But if not archenemal it must apparently correspond with either protonema or metanema. There is of course the possibility of arguing the derivation of the fern prothallium from archenema, and its independent differentiation into protonemal and metanemal stages. The

[8]Campbell, On the affinities of the Filicineæ. Bot. Gaz. **15**: 1. 1890.

prothallia of the Polypodiaceæ, Cyatheaceæ and Schizæaceæ, in which the first product of germination is a filamentous structure afterwards developing into a cordate thallus, or the rather poorly understood prothallia of the Ophioglosseæ may be considered as dimorphic gametophytes and interpreted accordingly. It will be seen, however, that protonemal and metanemal stages would in such case be analogous (not homologous) to the protonema and metanema of the Muscineæ, offering a case of parallel development under similar physiological conditions. And under the methods of classification proposed it is apparent that the conclusions of Goebel[9] can not yet be accepted. As to whether "we may regard as the starting point for Bryophyta and Pteridophyta alga-like forms consisting of branched filaments," judgment must, I believe, be suppressed for the present. It must first be determined whether the prothallium of the fern which is to be taken for the basal fern corresponds with algal archenema or with the protonema or metanema of the Muscineæ.

Conclusion.—The gametophytic structures below the ferns may be described under the heads of archenema, protonema and metanema.

It has not yet been clearly shown with which of these three series the fern prothallium is homologous.

Until the exact homologies of the fern prothallium are discovered, under such a classification it will not be possible to make full use of gametophytic stages in fern phylogenesis.

Phylogenetic argument based upon previous interpretations of the fern gametophyte may be considered as open to possible emendation.

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[9]Goebel, Zur Keimungsgeschichte einiger Farne. Ann. Buitenz. 7: 74. 1887.

Mutualistic symbiosis of algæ and bacteria with Cycas revoluta.

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WITH PLATES III AND IV.

Recently my attention was directed to the tubercle-like growths on roots of *Cycas revoluta*. A cursory examination showed that they were infested by a nostoc. In my search for the literature on the subject I found few and incomplete references. Between 1870 and 1873 Reinke discovered parasitic Nostocaceæ in species of Gunnera and Cycas. Janczewski discovered parasitic algæ in mosses, Cohn in Lemna, Kny in Florideæ and Strasburger in Azolla.

Reinke is to my knowledge the only person calling attention to an Anabaena found parasitic in a specialized parenchyma layer of Cycas roots. His incomplete though exact description has induced me to study the subject more closely.

Cycas root tubercles, which are simply short somewhat enlarged dichotomously branched rootlets, are quite common on most of our cultivated cycads. They occur on young as well as on old plants. The youngest plants at my disposal were about two years old. Only a few tubercles were present. A large, well nourished plant about twenty-four years old had many tubercles. They were most numerous near the surface of the soil; a few were wholly above and some were found a foot or more below the surface. Usually they are formed from the ends of rootlets, sometimes from the side of root branches, especially the single unbranched tubercles. In position they show evidence of negative geotropism. This is very marked in tubercles near the surface of the soil. Branching is always dichotomous (see plate III, fig. 3). Branches are short and somewhat spindle-shaped, the ends being bluntly rounded. Why they should branch dichotomously is interesting. It is probably a form of atavism showing the relation of cycas to the vascular cryptogams. Likewise the occasional dichotomous branching of leguminous tubercles may indicate a descent from cryptogams.[1] As to color one may readily distinguish

[1] It may be mentioned here that the relative positions of the phloem and xylem in the vascular system of leguminous tubercles corresponds to that in Cycas.

three kinds of tubercles. Those of a yellowish tan color, generally found above the surface, are devoid of the symbiotic algæ; the second variety, of a slightly darker tan and often greenish near the tip, always contain the algæ; they are the younger tubercles. The third variety, which also contain the algæ, are of a dark brown color and are older than the others. These three varieties are found on the same plant. In external appearance they resemble somewhat the tubercles of *Pisum sativum*. Morphologically they differ considerably. In pea tubercles the symbionts are surrounded by the vascular bundles while in Cycas the symbionts surround the centrally located vascular system. They resemble each other in their mode of branching.

Their mode of development is quite simple. Either the ends of rootlets branch dichotomously or they develop endogenously. It may be more correct to say that all tubercles develop like primary roots and that the lateral development is only apparent. That is the developing lateral root branch receives its tubercular peculiarity from the very start. The line of demarcation between rootlet and tubercle is very distinct and abrupt. The tubercle branch has about three or four times the dimensions of a rootlet of the same length.

On making a cross section of any part of the tubercle excepting the tip one can see with the naked eye a green circular layer about midway between the epidermis and bundle sheath. This is the alga-bearing layer. At certain points this green layer is discontinuous. This always occurs opposite outer lenticular structures which are quite common on the tubercles and are arranged in more or less broken rings. Having thus treated of the gross anatomy I shall next describe the minute anatomy.

A cross section shows six tissue layers. The first and outermost is the dermal layer of irregular corky cells several rows in thickness developed from a dermatogenic layer dividing tangentially. In the dermal layer are also included the lenticular structures consisting of enlarged irregular corky cells which do not seem to develop from any definite phellogenic layer. The cell walls of the dermal layer give to the tubercle its yellowish or dark brown color. The cells contain, besides the remains of nuclei and cytoplasm, various kinds of rhizobia in comparatively small numbers. The entire surface of rootlets, roots and tubercles is more or less covered by rhizobia, bacteria, hyphal fungi and various species of algæ, the discussion of which will be taken up below. The second layer is the dermatogenic layer of tangentially elongated rectangular thin walled cells. The third layer is the subdermal parenchyma of large rounded cells with intercellular spaces and air conducting passages. Considerable starch is present and often oil globules are found toward the inner side where the most rhizobia and bacteria are also found. The fourth layer is of the most importance. It consists of two opposite rows of palisade cells. This layer is only present in tubercles bearing algæ and is formed from radially elongating parenchyma cells beginning near the apical area of the tubercle and extending near the point of separation between tubercle and rootlet. The two rows of palisade cells are separate or only loosely connected in the middle. The cells are thin walled, about two or three times as long as broad, with large nuclei suspended in a granular cytoplasm. The large intercellular spaces are entirely filled with algæ (*Nostoc* sp.?). Besides the granular cytoplasm, the cells contain starch, amyloplastids, sometimes oil globules, and a waxy body near the base. The fifth layer or parenchyma proper resembles the subdermal parenchyma. The cells contain much starch. Numerous cells entirely filled with a waxy substance are present. The sixth layer is the vascular system sheath consisting of modified parenchyma cells of several layers thickness. The vascular system need not be described as it is the same as that of the ordinary root.

A longitudinal section shows the presence of a rudimentary root cap consisting of elongated loosely connected cells covering more or less perfectly the rounded end of the tubercle. The apical area consists of small prismatic closely united meristem cells. The palisade cells do not extend quite to the apex. (See plate III, fig. 2.)

The exact cause of the development of these tubercles I am unable to state. That there is excessive metabolism is very evident from their appearance and the large amount of albuminous substances present. That the infecting algæ are not the cause of their development is shown by the fact that tubercles exist without the alga-bearing palisade layer. On making a comparative study of Cycas roots and tubercles I found the following differences: The dermal and apical area of tubercles contained more rhizobia and bacteria than similar structures in ordinary roots and rootlets. Also the cytoplasm of tubercular cells is more granular, that is, it contains larger and more prominent dermatosomes, especially the palisade cells. It is very likely that whenever a certain amount of rhizobia and bacteria have infected the apical area of a certain rootlet, their irritating presence produces increased metabolism and rapid branching. Thus the increased number and size of the dermatosomes would be due to the rhizobia.

The question of the symbiotic relation of Cycas, algæ and rhizobia is very interesting and apparently rather complex. All soils, especially green house soils, contain rhizobia and other bacteria besides numerous algæ. These algæ are very common both in the soil and the vessels in which green house plants are grown. That they play an important part in binding the free nitrogen of the air has been conclusively shown by B. Frank. In examining carpellary and the rudimentary hypsophyllary leaves of Cycas it was seen that they often had a greenish coating consisting of algæ. The following genera were noted: Protococcus, Navicula, Chroococcus, Oscillaria, Glœocapsa, Ulothrix, Chlœosporium and Nostoc. Numerous rhizobia, bacteria and several species of hyphal fungi were also found. Among the rhizobia I could readily recognize *Rhizobium mutabile*,[2] *Rhizobium curvum*, and *Rhizobium Frankii* beside many, to me unknown, species of bacteria and cocci. Examination of the surface soil in which the plant grew showed a similar protophytic flora though in somewhat lesser abundance. The predominating types among the algæ seemed to be Protococcus and Nostoc. Among the rhizobia and bacteria I could find no predominating type.

Cross sections of tubercles showed that no algæ are inside the cells, while nearly all of them, especially those of the dermal layer, contained more or less rhizobia and bacteria. Parenchyma cells and bast cells of vascular system contained some rhizobia and bacteria. They seemed to be quite abundant in the apical area. Culture experiments developed three predominating types; a coccus, a probable rhizobium resemblimg *Rhizobium Frankii*, and a larger Indian club shaped bacterium resembling somewhat *Rhizobium mutabile* of *Trifolium repens* though smaller and of a more constant size and form (plate IV, figs. 6, 8).

[2]Bull. Torr. Bot. Club. **19**: 203. July, 1892.

Culture experiments were made with special precautions to prevent the introduction of bacteria, etc., everywhere present on the surface of both tubercles and roots. As a suitable medium a slightly acid agar-vegetable root extract was prepared. Tubercles of normal appearance were secured and carefully and thoroughly washed with plenty of hydrant water then quickly dried by means of blotting paper which had been passed through the flame of a Bunsen burner. A tangential section, including somewhat more than the dermal layer, was made down one side of the tubercle, then the tubercle was passed through the flame of the Bunsen burner so as to singe it thoroughly on all sides, and then broken (not cut) across. Inoculations were made from the broken surface farthest from the cut side. The inoculated tubes were placed in a dark chamber at the ordinary summer temperature (Ills.). In about six or seven days a small whitish growth was noticed in most tubes. Cultures made from the dermal and hypodermal parenchyma generally developed organisms resembling *Rhizobium Frankii* (plate IV, fig. 6), and I shall provisionally place them with that genus. Inoculations made from the palisade layer sometimes developed a coccus, more often there was no growth at all. As a rule there are no bacteria or cocci to be found with the infecting nostoc. Cultures made from the vascular system, especially near the apical area, generally developed the above mentioned *Rhizobium*, but more often a peculiar Indian club shaped organism (plate IV, fig. 8). I was unable to obtain absolutely pure cultures, but the two forms of bacteria (or rhizobia) described seemed to predominate. Cultures in which the rhizobium-like organism predominated finally took on a yellowish color. In this respect it resembled very much cultures of the rhizobia from the "Infektionsfäden" of *Melilotus alba* or *Trifolium pratense*. This organism resembles in appearance *Rhizobium Frankii* of *Phaseolus vulgaris* but differs in that it has cilia and is motile during its earlier life history.[3] Rhizobia and bacteria are not present in large numbers in any part of the tubercle. The question whether their presence is purely accidental or whether they live in active mutualistic symbiosis with Cycas could not be determined in the short time at my disposal. It is however quite certain that tubercles contain more bacteria

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[3]Further experiments in regard to the determination of the rhizobia are now in progress.

and rhizobia than the normal root. It is also certain that there is greater cytoplasmic activity in tubercles than in the normal roots; this is shown by the greater abundance of albuminous substances present and the greater prominence of the cytoplasmic granules[4] (Dermatosomen, Plasomen, etc.) (plate IV, fig. 7).

As already stated the dark tan and dark brown tubercles always contain the infecting nostoc. It is generally taught that algæ can not develop in the dark. This is evidently not true as some of the nostoc-bearing tubercles are found as much as a foot below the surface of the soil. In fact tubercles wholly above the ground never contain the nostoc. That the nostoc is the cause of the development of the palisade layer is quite evident from their constant association.

The exact mode of infection is as yet undetermined. The nostoc no doubt enters the parenchymatous tissue of the tubercle through a break in the dermal layer soon after it begins to form. Why the nostoc should take up a definite position in the parenchyma midway between the dermal layer and vascular system sheath is as yet unexplained. The parenchyma cells nearest the nostoc appropriate the extra nitrogenous compounds stored by the infecting symbiont, this produces hypernutrition of the incipient palisade cells which elongate in a direction parallel to the easiest conductivity of nutritious substances, that is practically at right angles to the vascular system. They serve a similar function to palisade tissues in other positions, as in leaves. Nostoc, so to speak, takes the place and serves the function of chloroplastids in true palisade cells.

Nostoc is the only alga found in the tubercles. This is probably because it is more closely related to Schizomycetes than Protococcus or Ulothrix. It is therefore better adapted to lead a parasitic or a symbiotic existence. From a study of the infecting alga I conclude that it is *Nostoc commune*. Reinke placed it with Anabæna since he could detect no gelatinous imbedding material. I found however that they were quite firmly united to each other and to the palisade cells by a gelatinous substance. Cells are spherical, loosely united, forming longer or shorter strings. Division takes place at right angle to nostoc chain. Sometimes a cell divides parallel

[4] Contribution to the probable biology of Plasomen, Bull. Torr. Bot. Club **20**: 339. Oct. 1893.

to nostoc filament thus producing a new filament at right angles to the original. I could detect no difference in color and general behavior from nonparasitic nostoc cells. Heterocysts increase in number with the age of the tubercle. Sometimes, in very dark colored tubercles, heterocysts are present in greater numbers than the normal cells. I could detect no spore formation.

From the appearance of the host it seems quite evident that the infecting symbionts are far from harmful. The omnipresence and importance of schizophytic organisms in and on tissues of vascular cryptogams and gymnosperms is probably far from being overestimated.

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EXPLANATION OF PLATES III AND IV.

PLATE III.—Fig. 1. Portion of cross section of *Cycas revoluta* tubercle representing dermal (lenticular), dermatogenic, subdermal parenchyma, palisade, and parenchyma layers. Nostoc *in situ*.

Fig. 2. Portion of longitudinal section of tubercle showing apical area without the root cap. Beginning of palisade layer with a few nostoc filaments.

Fig. 3. Diagramatic section of tubercle, showing manner of branching and distribution of vascular bundles.

Fig. 4. *Nostoc commune*.

PLATE IV.—Fig. 5. Some of the parenchyma and palisade cells highly magnified showing reticulated structure of cytoplasm and nucleoplasm. Larger black dots in cells represent full grown plasomes or dermatosomes. Starch and resinous bodies in some of the palisade cells.

Fig. 6. *Rhizobium* sp. ? from dermal layer.

Fig. 7. Plasomes from palisade cells.

Fig. 8. Bacteria from parenchyma and vascular tissue

(Figs. 6, 7 and 8 very highly magnified.)

Botanical notes from Bainbridge, Georgia.

AUGUST F. FOERSTE.

Oaks as weeds.

I suppose it is hardly proper to refer to any plants not herbaceous as weeds. Yet when the planter finds a ligneous plant which is becoming a nuisance and which is fast making itself a pest, he wishes a word which will express his meaning to other people. Seven years ago the plantations of the vicinity contained many open forests, in which pines predominated, and in which the oaks though abundant were rarely thought of. These pines are *P. australis* Michx., *P. Taeda* L. and *P. mitis* Mx. Among these the first greatly predominates. With its long leaves, often 15 to 20 inches long, it adds fully as much to the picturesqueness of the south as does the pendent Spanish moss. It is also a valuable tree, not only for its turpentine and resin, for which it is the center of an important industry, but also for its lumber. To be sure, in the north its enormous weight would not permit it to stand competition with the lighter pines, but here in the south it is used for everything.

Now the oaks are coming in so thick as to obstruct and often to prevent the natural seeding and development of young pines. But this is not all. In a country where the climate is so favorable that cattle need feeding only two or two and a half months during the year, the raising of cattle and other grazing animals is an important industry. Now it happens that the invasion of oaks is so great that they shade so much of the ground as to check and limit the development of grass to a tremendous extent, and it is no longer possible to raise so many cattle to the acre without feeding. At present, the writer has before him a landscape of this description, into which these oaks have intruded within the knowledge of the present generation. Eighteen years ago it was all pine woods. A person could drive in any direction and the black-jack oak was only occasionally met. Even now it is rare to find any black-jack oak of any size. They commenced gradually to enter this territory, at first attracting but little attention. Seven years ago the danger of the black jack oak invasion was already clearly foreseen, and now they are over many acres so thick as to interlock their branches, though the trees are only ten to fifteen feet high. Even on foot it is at times a nuisance to penetrate through the thicker growths, often several acres in extent.

The invasion seems to be from the north. At Marianna, and along the Appalachicola and Chipola in western Florida, they have not yet become a pest. West of the Flint the country was until lately quite free of them as a nuisance, but within the last several years reports have been coming in of the invasion of also that territory. Pines go deeper for their food. Oaks seem to require more potash and more phosphoric acid. Whatever the reason may be, nature, who has been raising pines for a long time, seems to have determined to quit the business, and has directed her attention to raising oaks. Perhaps the pines have exhausted the soil of certain elements, and have left others favorable to the growth of oaks in excess.

An additional observation must here be recorded. Fire is set in winter to the grass in the woods to act as a natural manure for the coming spring. The pines catch fire more easily, owing to their pitch, and the cambium layer is readily killed by heat. Oaks under similar circumstances suffer much less. A plantation house recently burnt down. Being a log and board house built of the rich pitch pine of the country, the heat was intense for an hour at a distance of a hundred feet. All the pines in the vicinity were killed. Five steps away from the sills of the house in the direction of the draft of the fire are black jack oaks, which have put out fresh branches all along the side of the tree away from the house, and those within a foot of the house are putting out branches from the roots. It was hoped that they were dead. Young fresh oaks are springing up everywhere near the burnt ground. Still this readier resistance to fire by oaks is only a very partial factor. On some plantations forest fires have not been allowed for some years on this account, but the oaks are still advancing. The worst oak in this respect is the black jack oak, *Quercus nigra* L., and it is to this oak that the term *weed* would apply. The Turkey oak, *Q. Catesbaei* Michx., is common but not feared.

Near the above mentioned house stood a pine about eight inches in diameter. A storm had inclined it to about fifteen degrees from the perpendicular towards the north. Since then (in three years) the upper twenty-five feet of the tree had distinctly curved back towards a perpendicular, being inclined only about seven degrees. That it should have done so considering the thickness of the trunk even at this distance (thirty feet) from the ground seems strange.

A new compass-plant.

A walk through any bit of open woodland in July is certain to reveal the presence of quite a number of plants whose leaves have assumed a more or less vertical, instead of horizontal position, owing to a twist in the petiole, or, if the leaf be sessile, in the lower part of its blade, near the base. This is especially common among the *Compositæ*, where such names as *Seriocarpus tortifolius* Nees, and, possibly, *Solidago tortifolia* Ell. record the fact. A species of *Aster*, with ovate-oblong leaves, having a sessile, cordate base, shows a strong twist of the entire leaf towards the right or towards the left, but often in the same direction over the major portion of the same plant.

In *Sericocarpus tortifolius* the twist is confined to the narrowed base of the leaf; in some plants the twist is such that most of the lower leaves turn their upper surfaces towards the south, while the upper younger leaves do not show this tendency; in other plants even the lower leaves show no regularity as to which side is presented to the sun.

In various species of *Liatris* the twist is confined more or less to the lower half or third of the leaf and the twist is quite regularly in the same direction, so that looking at the plant from above the twist of the leaf blades gives it an effect a little like that of a screw. In general the twist is such that, holding the stem so as to place the leaf to be examined toward the right hand of the spectator, the upper surface of the leaf is directed towards him. *Liatris scariosa* Willd. shows this arrangement and *Liatris graminifolius* Willd. gives the screw-like effect very strongly. Other species of the genus show it. In a less distinct manner *Hypericum angulosum* Michx. shows the twisting of the leaf blades.

What is the meaning of this twisting of the leaf blade? Where the leaf blade is twisted throughout its entire extent the cause may be a little dubious, but where the twisting is confined to the basal portion of the leaf it seems quite evident that the resulting vertical portion of the leaf blade is of service in evading more or less the full effect of the sun's rays during the hottest part of the day. This is true even of those cases of *Sericocarpus tortifolius*, in which most lower leaves face the south, since the vertical position of the leaf blades places them at an angle to the sun's rays which is more advantageous than a horizontal position would be.

The same result is secured in other plants by simply assuming an erect position. A form of *Linum Virginianum* L. is an interesting variation of this habit. Here the leaves are linear, 11^{mm} long, erect, appressed to the stem, and slightly twisted so as to fit still more closely against the stem, both toward the right and toward the left. The lower side of the leaves is thus exposed and the upper side more or less protected. In its earlier history the plant must have been simply a case of vertical leaves. *Aster adnatus* Nutt. must also at one time have had leaves entirely free from the stem, but erect, and more or less appressed to the same. In that position the lower half of the midrib became adnate to the stem and since then the upper half of the leaf has again resumed a tendency to spread.

It is *Aster concolor* L., however, which is the most interesting of the latter class of plants. Here the upper leaves are erect, appressed to the stem, and rather crowded. Towards the base they are larger, less numerous, and no longer so erect, but have rather an ascending position. They here also show a very marked tendency to place their vertical leaf blades in a north and south plane. This tendency disappears, or rather, is obscured among the more crowded and erect upper leaves. Where exposed to the sun freely the north and south position of the lower leaves is very evident and the plant thus becomes another case of a compass plant.

The case of the compass plant of the western states, *Silphium laciniatum* L., is too well known to require more than mention. A number of years ago, the writer, I think, had occasion to describe in this journal a similar phenomenon in thoroughly exposed plants of the prickly lettuce, *Lactuca Scariola* L. And now *Aster concolor* L., becomes a third. All of these belong to the *Compositæ*. The fact that these phenomena seem confined to those plants which delight in open sunny places, and which grow in the warmest part of the year, gives additional weight to the argument that they show evidence of a tendency to evade the hottest and most direct rays of the sun.

A curious rose.

A neighboring planter, Mr. Griffin, has a rose bush bearing constantly green roses. The calyx is fairly normal. The outer petals are small green simple toothed leaves, in other words, like any small leaflet from a rose leaf. The interior petals become less green, and more pale, and gradually less toothed, the upper teeth remaining the largest. The stamens are linear pale green flat petal-like bodies, abruptly expanded at the top, the outer ones notched at the apex. The achenia, on the contrary, are expanded at the base, and narrowed at the top, forming ovate lanceolate pale petal-like bodies. Of course there are no seeds, and the green roses appear on the same bush from year to year.

Fungi.

The first of July is the middle of the rainy season in the south, which lasts about two months. Florida and adjacent Georgia lie within the area of one of the heaviest rainfalls on this continent. During these months it rains frequently, often for several days. Yet there are almost no fungi of such kinds as would be apt to be found by a student not familiar with microscopic forms. A trip down the Chattahoochee and Appalachicola in May, and another down the Chipola, and through Dead Lakes, revealed almost no fleshy fungi, except a few specimens of a lateral stemmed *Agaricus* on a stump in the lakes. Fleshy fungi are, however, common in December and early January, and are moderately common again in February when the spring flowers begin to be frequent. No attempt was made to keep a record of the same. Prof. W. G. Farlow was so kind as to determine the following species of gasteromycetes for me, which are common late in December: *Rhizopogon rubescens* Tul., *Hydnangium Ravenelii* B. & C., *Lycoperdon acuminatum* Curtis (=*L. leprosum* B. & Rav.), and *Clathrus columnatus* Bosc.

Fossil palmettoes at Alum Bluff, Florida.

While on a geological trip with Prof. Raphael Pumpelly, the writer found that the palmetto leaves and trunks of that locality came from near the base of the middle Miocene Alum Bluff sands, just above the Chipola bed of which it represents the later fresh water facies. Above the sands lies the Chesapeake bed. This makes it probable that the wide spread Grand Gulf group of the lower Mississippi basin, including localities providing similar palmetto leaves, also began its history at a date as early as the middle, pre-Chesapeake, Miocene. In this connection it may be of interest to notice that among the strongly washed marine fossils of Chipola age, at Gasteropod Gully, on Roseland Plantation four and one-half miles south of Bainbridge (owned by Prof. Pumpelly and Major T. B. Brooks), were found two land gasteropods, one a *Helix* somewhat resembling *H. adamnis* Dall, and the other four and one-half whorls from the upper part of a *Bulimulus*, similar to *B. Heilprinianus* Dall. In those days of the Chipola Miocene the Gulf Stream had a passage between what was then the island of Florida and the mainland of central Georgia and regions north. Gasteropod Gully must have been near the south shore of this mainland and received its land shells from that direction. The locality at Alum Bluff is also a marine deposit, as is shown by the oysters and other shells not at all so very rare in these Alum Bluff sands. Indeed the Chipola fossils run up into the base of these sands. Some of the oysters occur at higher levels than the plants. The water may, however, have been very shallow and brackish. The locality is a very important one in that it enables the correlation of horizons in the widely extended Grand Gulf deposits, with this more local sandy late Chipola bed. Hitherto there has been no *proof* of their earlier than post-Chesapeake Miocene age. The writer is of the opinion that the Grand Gulf series includes horizons which are equivalent in time to the earliest Miocene or Chattahoochee limestone deposits of Florida and southwestern Georgia, but this is hardly the place to develop this idea.

BRIEFER ARTICLES.

Three new species of Mexican plants.[1]—**Guarea Palmeri** Rose (*in littera*).—Foliis modice petiolatis 2–6-jugis, foliolis oppositis subsessilibus e basi cuneata oblongis vel obovato-lanceolatis apice obtusis supra glabris subtus ad axillas nervorum secundariorum pilosis, paniculis simplicibus racemiformibus, calyce obtuse 4-partito, ovario glabro 4-loculari loculis uniovulatis, capsula subglobosa glabra laevi, semine in arillo laete rubro immerso.—In Manzanillo (*Palmer* 1391).

Arbor mediocris 5^{m} alta glabra, Marte fructifera, corona lata symmetrica. Rami pallide fuscescentes lenticillis concoloribus. Folia 12–26^{cm} longa. Foliola ad 12^{cm} longa ad 4^{cm} lata in sicco firmula pallida subopaca epunctata supra nitentia, nervus secundariis utrinque circiter 8. Rhachis cum petiolo circiter 2^{cm} longo teres glabra. Paniculæ hornotinæ axillares. Capsula pallide fuscescens 2^{cm} longa 22^{mm} lata 4-locularis. Cotyledones transverse superpositi crassi, radicula inclusa, plumula minima.

Species *G. brachystachyæ* C. DC. et *G. filiformis* C. DC. affinis.

Trichilia Palmeri.—Foliis parvis modice petiolatis 3-foliolatis, foliolis petiolulatis lanceolatis basi aequali acutis apice breviter obtusa cuspidatis supra glabris subtus velutino-puberulis, paniculis glabris breviter ramulosis fructiferis quam folia multum brevioribus plerumque monocarpinis, capsulis apice ramulorum sessilibus globosis parvis, valvis ovato-acutis glabris extus nigrescentibus lenticellis pallidis numerosis conspersis, seminibus ellipticis.—In Mexico (*Palmer* 1,292).

Februario fructifera. Ramuli glabri pallide fuscescentes lenticellis albis conspersi. Folia ad 9^{cm} longa. Foliola in sicco firmo-membranacea inconspicue subtiliter pellucido-punctulata subpellucida, terminalia 7.5^{cm} longa 3^{cm} lata lateralia parum minora, nervis secundariis sub-

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[1] While engaged in determining Dr. Palmer's collection from the state of Colima, Mexico, I came across three peculiar species that puzzled me very much. They all belong to the order Meliaceæ, none were in flower, but all had mature fruit. One I determined to be a new species of Guarea and the other two were tentatively referred to Trichilia I finally submitted them to M. C. de Candolle, who has just reported upon them, requesting that his descriptions be published in the BOTANICAL GAZETTE. The following note accompanied his descriptions: "I did not answer sooner about these plants because two of them greatly puzzled me for some time, owing to the fact of their leaves and fruit showing all the outward characters of true *Trichilia* combined with the abnormal presence of perisperm in the seeds. But having received from Capt. John Donnell Smith a third plant with flowers as well as fruits, which unmistakably belongs to *Trichilia*, although its seeds contain perisperm, I now hesitate no longer to refer yours to the same genus."—J. N. ROSE.

adscendentibus suboppositis utrinque 8–10. Petioluli ad 6^{mm} longi subtiliter puberuli. Petioli ad 2^{cm} longi. Paniculæ hornotinæ axillares glabræ. Capsula paulo latior quam longa, circiter 7^{mm} lata. Semina circiter 4^{mm} longa elliptica in sicco flavicantia. Embryo perispermio albo tenui inclusus, cotyledonibus carnosis basi cordulatis, radicula exserta subrotunda, plumula minima.

Species sicut subsequens ac tertia e Guatemala alio loco describenda semine perispermium includente radiculaque e cotyledonibus exserta a caeteris *Trichiliis* quorum fructus notus est discrepans.

Trichilia Colimana.—Foliis modice petiolatis 5–6-jugis, foliolis subaequalibus petiolulatis oppositis subalternisve lanceolatis basi leviter inaequali acutis apice acute acuminatis supra subtusque densius pilosulis, paniculis fructiferis simplicibus quam folia pluries brevioribus, capsulis pedicellatis 3- vel abortu 2-valvatis, valvis late ovatis transverse rugulosis hirsutis, loculis monospermis, seminibus subglobosis arillo aurantiaco circumdatis.—In Colima (*Palmer* 1,117).

Ramuli adulti glabri, in sicco rufescentes lenticellis pallidioribus inconspicuis. Folia ad 30^{cm} longa impari-pinnata. Foliola superiora caeteris parum majora ad 7.5^{mm} longa ad 22^{mm} lata in sicco firmule membranacea inconspicue subtiliter pellucido-punctulata, nervis secundariis subadscendentibus utrinque 10–12. Rhachis cum petiolo 7^{cm} longa teres pilosula. Paniculæ fructiferæ circiter 8^{cm} longæ. Capsularum valvae circiter 1^{cm} longae. Embryo intra sacculum persistentem extus perispermio pulverulente albo circumdatum inclusus, cotyledonibus carnosis ellipticis, radicula exserta brevi obtusa, plumula minima. —CASIMIR DE CANDOLLE, *Geneva, Switzerland.*

Frost freaks of herbaceous plants.—The very interesting article by L. F. Ward on "Frost Freaks of the Dittany"[1] called to my mind some very interesting observations which I made on this plant during the winter of 1885–6, while connected with the University of North Carolina. This plant is very abundant in the open woods at Chapel Hill where the University is located. During a short excursion one frosty morning the curious frost foils on the stems of *Cunila* attracted my attention. On these particular plants the frost laminations did not usually conform to the regular arrangement described by Mr. Ward, though sometimes the regular arrangement in whorls of two or four did occur. The sheets did however stand out vertically from longitudinal slits in the stem and were curved into multitudinous forms forming imitations of numerous objects. One case I particularly remember where two sheets issuing from parallel rifts quite near together, diverged as they extended outward from the stem, and then

[1] BOTANICAL GAZETTE, **18**: 183. 1893.

gradually approached forming a perfect imitation of the shell of some lamellibranch. I found upon observation that the longitudinal bars on the sheets were due to slight inequalities in the thickness, caused by corresponding inequalities in the size of the rift in the stem. During the process of crystalization of the water at the surface of the cambium layer its expansion caused it to be expressed outward or vertically to the plant since this was the direction of least resistance to the forming ice foil. The forming crystal passing through the rift would be moulded into a fashion, so far as the thickness is concerned, corresponding to the inequalities of the rift. During the first stages of the crystalization frequently portions of the dead epidermis or periderm would be included, and as the foil extended outward considerable portions of the dead outer part of the stem would be carried out upon the terminal portion.

Although familiar with the frost freaks of *Helianthemum Canadense* from the statements in manuals, I had never seen them, and this phenomenon on the stems of *Cunila Mariana* seemed to me to be of some interest which would possibly justify some extended notice of it together with colored illustrations. Accordingly I engaged an artist friend to color in oil one of the most beautiful of the specimens. Since the frost work could not be taken in doors without fatal results to its form and beauty, and it would be rather chilly working at an easel in the frosty air of a cold morning, the object was placed just outside the window while the artist sat within. A very good picture was the result but further consideration of the subject led me to believe that the phenomenon was of such common occurrence throughout nature it was not worthy of the very dignified treatment which I had in mind at the start. So the matter dropped so far as I was concerned and this interesting phenomenon waited seven long years to be recorded.

Several mornings during that and following winters the frost marvels were observed, and each time also there occurred the well known phenomenon of the formation of ice columns in moist soil, where the crystallization of the surface moisture causes the forming crystal to expand vertically to the earth since that is the direction of the least resistance. Capillarity of the soil provides the constant supply from below where the soil is not frozen, and columns are pushed up several inches in height, carrying upon their summits portions of the surface soil and refuse matter in the way of leaves, etc. Warm or mild days and frosty nights, when the ground is not already frozen, favor both the formation of the ice columns in moist places on the ground, and the frost wings on the stems of the dittany. The perennial root system probably does not supply by capillarity the constant stream of water as does the capillarity of the soil. But I do not think it unreasonable to suppose that there is a degree of root activity which furnishes the necessary water. The cold being superficial the water in the surface of the cambium crystallizes, the dead periderm cracks, and through the rift the nascent laminate crystal pushes its way.

A specific variation in the root activity of different plants as related to different temperatures explains, I think, why *Cunila Mariana* of all the plants Mr. Ward mentions forms the crystals. I discovered also one other plant which produced these frost freaks, but as the subject was losing what had seemed to me at first its very serious aspect, I did not take the trouble to accurately determine either the species or genus of this additional frost weed. From the observations which I made at the time I can safely say that it was either some species of *Eupatorium* or *Vernonia*, more likely the latter. I regret now that I did not accurately determine the species.—GEO. F. ATKINSON, *Botanical Department, Cornell University.*

A hybrid Baptisia.—Several specimens of a *Baptisia* have been collected in the vicinity of Manhattan which can not be referred to any of the species of the genus. The two species occurring here are *B. australis*, characterized by its glabrous foliage and erect raceme of blue flowers, and *B. leucophæa*, with hairy foliage and a reclining raceme of cream-colored flowers. The specimens referred to are intermediate in all these characters, even to the party-colored flowers, and are apparently hybrids between the two species. Fruiting specimens have not been observed.—A. S. HITCHCOCK, *Agricultural College, Manhattan, Kansas.*

CURRENT LITERATURE.

Microscopical methods.

American botanists are much indebted to Dr. James E. Humphrey for translating and to Messrs. Henry Holt & Co. for publishing a very valuable work on botanical microtechnique. The work was written by Dr. A. Zimmermann,[1] privat-docent in the University of Tübingen, and published in Germany last year.

It is rare that such a wealth of detailed information is condensed into so small space. The general methods of observing, staining and mounting specimens are first taken up, followed by microchemical methods, methods for investigating the cell wall and the various cell contents, some account of the preparation and examination of bacteria, and a list of literature and an index. The variety of substances which may now be detected microchemically is astonishing. Over one hundred compounds or groups of compounds are treated in the third of the volume given to microchemical methods. An equally great number of substances are dealt with in the next third of the volume, relating to the cell wall and cell contents.

In using the work some disappointment will be felt now and then on account of the brevity with which many of the topics are treated, but this fault, arising from the multiplicity of topics, is partly atoned for by the careful citation of literature, the page as well as the volume being named.

Nearly two hundred authors are mentioned in the enumeration of literature, and two or three times as many distinct works. The text has not, however, been merely compiled from these abundant data, but the author has tested a large part of the methods, and given his views of their value, often suggesting excellent modifications.

The work of the translator has been well done. He has taken occasion to add a few items to the text, the most important being in regard to celloidin imbedding. He has also added to the appendix a series of very useful reference tables, notably a table of specific gravities and percentage composition of a few common solutions and De Vries' table of "isotonic coefficients" comparing the water-absorbing power of six great groups of compounds. The author has also

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[1] ZIMMERMANN, A.—Botanical microtechnique: a handbook of methods for the preparation, staining, and microscopical investigation of vegetable structures. Trans. from the German by JAMES ELLIS HUMPHREY. 8 vo. pp. 296. figs. 63. New York: Henry Holt & Co. 1893. $2.50.

assisted the translator in supplying paragraphs upon recent investigations, thus bringing the work fully up to the time of publication of the American edition.

The typography and binding are satisfactory. Altogether the book is admirable, and no microscopical laboratory can afford to be without it.

Minor Notices.

THE MYRTLES of Brazil have just been enumerated by Hjalmar Kiærskou[1], being a part of the work on the flora of Central Brazil edited by Eug. Warming. This characteristic Brazilian family is represented as containing 418 species, 120 of which are described as new. Of the 13 genera, *Myrcia* and *Eugenia* contain over 300 of the species. *Myrcia* is represented by 154 species, 37 of which are new, and *Eugenia* by 151 species, 52 of which are new. Only the new species are characterized. Of the 24 plates, 12 are from drawings, chiefly showing leaf form and venation, and 12 are very good reproductions of photographs of herbarium sheets.

DR. JOHN W. HARSHBERGER has published an exhaustive account of maize.[2] He has brought together matters of great interest, and this contribution will make a valuable reference paper. The scope of treatment can best be indicated by some of the titles. The chapters bear the titles: Botanical, Origin, Geographical Distribution, Chemical, Agriculture-Physiological, Utility, Economic considerations, Future. Under "Botanical", the gross anatomy, histology, and bibliography, are treated. Under "Origin", which is a very interesting chapter, meteorological, botanical, archæological, ethnological, philological, and historical proofs are considered, all of which are taken to prove a central Mexican origin. "Maize originated, in all probability, in a circumscribed locality, above 4,500 feet elevation, north of the Isthmus of Tehuantepec and south of the 22nd degree of north latitude, near the ancient seat of the Maya tribes. There is hardly a doubt but that the Mayas first cultivated maize and distributed it in every direction."

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[1] KIÆRSKOU, HJALMAR.—Enumeratio Myrtacearum Brasiliensium, etc. 8vo. pp. 200, 24 plates. Hauniæ, ex officina Hoffensbergiana, 1893.

[2] HARSHBERGER, JOHN W.—Maize: a botanical and economic study. Contrib. Bot. Lab. Univ. Penn. 1: *2*. 75–202. *pl. 4*. 1893.

NOTES AND NEWS.

DR. JOS. BOEHM, professor of physiological botany in the University of Vienna and also in the College of Agriculture, and an investigator of wide reputation, died December 2, 1893, at Vienna.

DE LAMARLIERE finds[1] that, for an equal surface, the leaves developed in the sun show a greater intensity of respiration, assimilation and transpiration than those grown in shade, the well known structural differences thus having a corresponding physiological significance.

IN PRESERVING anatomical as well as herbarium material, Heinricher avoids blackening of colorless saprophytes and parasites like Monotropa and Lathraea by plunging the living plant into boiling water for about a quarter of an hour and then transferring them to alcohol or placing in a press, as desired.[2]

MUELLER-THURGAU has shown that various phenomena in cultivated grapes, currants, apples, oranges, apricots and peaches, are directly related to the number of seeds formed. The more seed formed the greater will be the weight of flesh, the slower the ripening, the greater the amount of acid and the less the sugar.

MR. O. F. COOK sailed Oct. 25th for western Africa, to make further observations and collections of the plants of that region, especially of the cryptogamic forms. He will be gone a year or more. His former voyage resulted in securing a large amount of botanical material, and the present visit is expected to yield even greater results.

MACMILLAN & Co. of New York announce for early publication a work by Prof. G. F. Atkinson, entitled, "The study of the biology of ferns by the collodion method; for advanced and collegiate students." It is to be profusely illustrated, and is designed for laboratory instruction and for reference on the development and structure of ferns.

FOR MOUNTING preparations cleared with chloral hydrate which it is desired to retain in their transparent condition, Geoffroy suggests[3] a solution of 3–4^{gm} pure gelatin in 100^{cc} of 10 per cent. chloral hydrate. This can be used like glycerin, with the added convenience that it hardens at the edge of the cover, so that the cover can be cemented without tedious cleaning.

QUANTITATIVE DETERMINATION of sugars by fermentation is described by A. Lasché in the *Amer. Brewer's Review* **7**: 286–288. 1893. The method is given by which the percentage of dextrose, saccharose, maltose and isomaltose in glucose can be found by use of Saccharomyces apiculatus, S. Joergensenii, and S. cerevisiæ. Two types of the latter are required, the Frohberg type and the Saar type.

[1] Revue gén. de Bot. **4**: 481, 529. 1892.

[2] Zeits. f. Wiss. Mikros. **9**: 321–3. 1893.

[3] Jour. de Botanique **7**: 55. 1893.

Dr. F. Franceschi, of Los Angeles, Cal., has made a small collection of the Guadalupe Island plants. The plants of this island have been seldom collected. Although quite well known through collections of Dr. Palmer and Professor Greene, so many of the species are endemic, that almost any collection from the island is valuable. Dr. Franceschi has several sets to dispose of and solicits correspondence.

The question of the existence of a special membrane around the vacuole has been incidentally studied by Bokorny, who finds,[1] on treating cells with a 1 per mille solution of coffein, similar phenomena to those described by DeVries upon plasmolysis with a 10 per cent. salt solution. By the treatment with so weak a solution no plasmolysis occurs but the general protoplasm is slowly killed. The vacuole wall however remains living for a long time as shown by its reactions.

Agricultural Science, a journal of scientific merit, containing frequent articles upon botanical and other biological subjects, finds it necessary to increase its subscription price, after the close of the present year, from two dollars, the former price, to three dollars per year. This is for the porpose of enabling the publisher to keep up the high standard of quantity and quality of matter presented, which has already been attempted, but for which the financial support is not at present adequate.

A prospectus of a distribution of *Uredineæ Americanæ Exsiccatæ* by Prof. M. A. Carleton, has been issued. The fascicles are to contain fifty specimens which are to be sent out in white paper pockets, loose, with printed labels. The nomenclature will follow the best authorities, and notes on literature will find a place on the labels. Any one contributing sufficient material for four numbers of the distribution will receive a set free. The first fascicle is to be sent out about the middle of January.

The proceedings of the sixth annual convention of the *Assoc. of Agric. Colleges and Stations* (1892), recently distributed as Bulletin 19 of the U. S. Office of Exper. Stations, contains five botanical papers in full, viz.: On the treatment of apple scab, by E. S. Goff; A comparative test of fungicides in checking potato blight and rot, by L. R. Jones; A study of fruit decays, by B. D. Halsted; Notes on the breeding of fruits, by N. E. Hansen; and Crossing of cucurbits, by L. H. Pammel. The report of the section on botany gives a brief resumé of ten papers that were presented.

Mr. G. J. Peirce publishes in the *Annals of Botany* for September the results of investigations on the haustoria of the Cuscutas and some other phanerogamic parasites. The author finds the haustoria to be true lateral roots modified for their special work. In all the five genera studied, except the chlorophyll-bearing *Viscum album*, the mature haustorium was provided with an axial bicollateral bundle with two strands of ducts and two of sieve tubes. The haustorium of the parasite always penetrates to the fibro-vascular ring of the host and its xylem and sieve tubes are in direct communication with the corresponding parts of the host. The finding of sieve tubes in the haus-

[1] Biolog. Cent. **13**: 271. 1893.

toria of the Cuscutas when L. Koch and others had failed to discover them is especially interesting and throws much light on the food relations of the parasite and its host.—R. A. HARPER.

A great portion of native botanic drugs are collected in the mountain portions of North Carolina, South Carolina, eastern Tennessee and Kentucky and northern Georgia. The inhabitants of these regions, many of them, eke out a precarious living collecting drugs; men, women and children take part in the work. Gathered as they are by people who are often densely ignorant it is necessary before the drugs are put upon the market for them to pass through the hands of persons who make it a business to inspect, sort and identify the goods. In the pharmaceutical laboratory of Eli Lilly & Co., of Indianapolis, Ind., a botanical department [in charge of Mr. John S. Wright] is devoted to the identification and inspection of vegetable drugs.—*Lilly's Bulletin, No.* 23.

THE SERIAL, *Studies from the biological laboratory of Johns Hopkins University*, completed the fifth volume with the October issue. A general title page and index to the five volumes accompanies the last number. The botanical articles in these five volumes are as follows: Botanical relations of Trichophyton tonsurans, by I. E. Atkinson (I, No. I.; Land plants found at Fort Wool, by N. B. Webster, (I, No. 3); Researches on the growth of starch grains, by A. F. W. Schimper (II. 353); Observations on several zooglœæ and related forms, by William Trelease (III. 193); Formation of the so-called cypress knees on the roots of the Taxodium distichum, by J. P. Lotsy (V. 269); and On the origin and development of the stichidia and tetrasporangia in Dasya elegans, by B. N. Barton (V. 279).

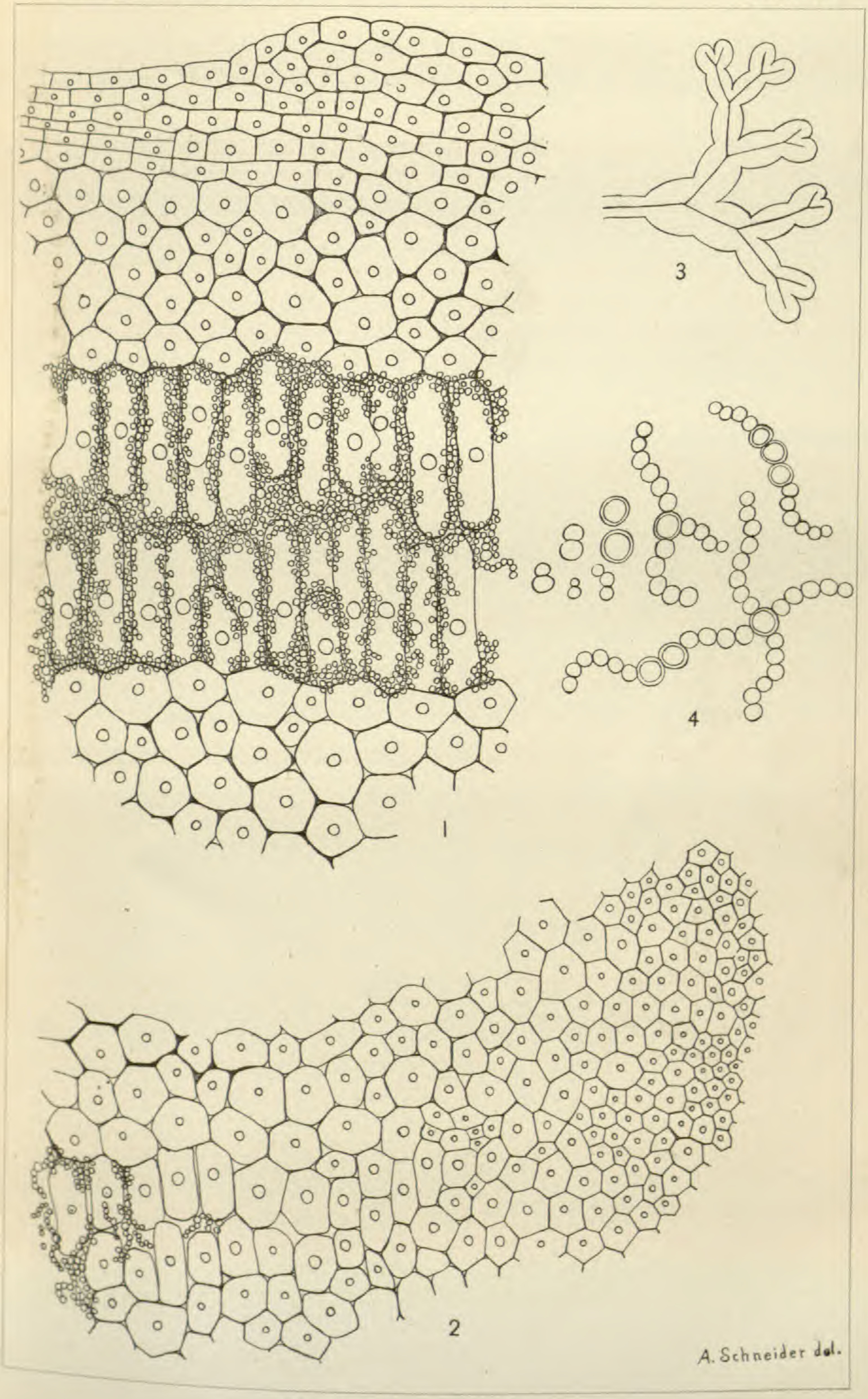
IN AN EXAMINATION of fifty species of fungi belonging to widely separated groups, by W. Wahrlich of St. Petersburg, in an article on the anatomy of the cell in fungi and unicellular algæ (in the Russian language), all were found to show a continuity of the protoplasm, except Oidium lactis, not only between vegetative cells, but also between the hyphæ and spores, and between the parts of many-celled spores. The connecting bands were clearly strands of plasma. The author arrives at the conclusion that the continuity of protoplasm is present in the fungi wherever transportation of material is necessary, and that plasma granules may pass from one cell to another in this way. In an experiment with Eurotium herbariorum this happened under the eye of the observer. (Cf. BOT. GAZ. 18: 437).—D. T. M.

THE ANNUAL MEETING of the Indiana Academy of Sciences occurred in Indianapolis, Dec. 27th and 28th. There was a good attendance, and the scientific interests of the state were promoted in many ways. One half day was given to the discussion of the work accomplished by the State Biological Survey, a voluntary organization under the auspices of the Academy, and of plans for its future. The following are the titles of the botanical papers read: Some notes on a variety of Solanum Dulcamara, by R. W. McBride; Review of botanical work in Indiana with bibliography, and Our present knowledge of the distribution of pteridophytes in Indiana, by L. M. Underwood; Histology of the Pontederiaceae, by E. W. Olive; Growth in length and thickness of the petiole of Richardia, by Katherine E. Golden; The effects of light on the germinating spores of marine algae, by M. A. Brannon; Notes on Saprolegnia, by Geo. L. Roberts; Contribution to the life history of Notothylas, by D. M. Mottier; Notes on evolution in the cacti, by J. M. Coulter; The ash of trees, Notes on the biological survey, and The stomates of Cycas, by M. B. Thomas; Poisonous influence of Cypripedium spectabile, Symbiosis in Isopyrum biternatum, and Work of the botanical division of the Natural History Survey of Minnesota, by D. T. MacDougal; Notes on sectioning woody tissues, Concerning the effect of glycerin on plants, and Notes on an imbedding material, by John S. Wright; and The adventitious plants of Fayette county, by Robert Hessler. Beside the above the presidential address by J. C. Arthur was a botanical theme. The special senses of plants.

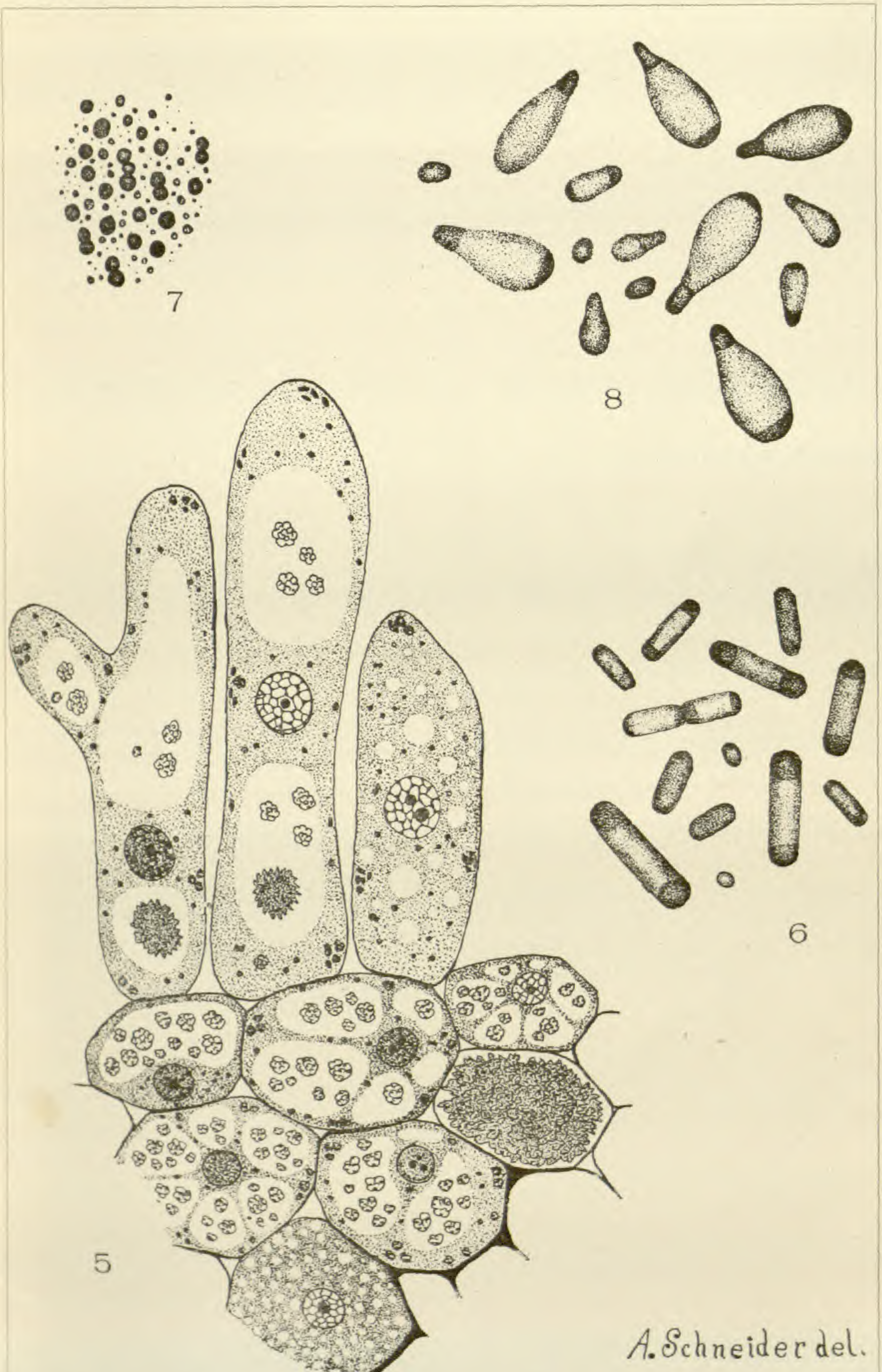
DR. H. SCHENCK recommends[1] a method of preparing unusually large and thick sections for permanent preservation so as to be useful for lecture demonstrations and for examination with the magnifier. The sections are first thoroughly permeated by glycerin by prolonged soaking; the superfluous glycerin is drained off and the section dried with filter paper; it is then placed in an abundance of a thin solution of Canada balsam in xylol and covered with a large cover glass. The glycerin does not mix with the balsam nor is it withdrawn from the object which remains perfectly clear. The method is applicable to sections of stems of large size, such as tree ferns, palms, etc., whether woody or herbaceous. Of course suitable sizes of slides and covers have to be obtained.

IMMEDIATELY FOLLOWING the World's Congress on Horticulture at Chicago in August last, a series of meetings was held to consider the advisability of organizing a horticultural society which shall include every country of the globe. After much discussion, in which many eminent men from various parts of the world engaged, the World's Horticultural Society was organized and the election of the three general officers was held, on the 25th of August. This new society is designed, in the language of the constitution, "to promote correspondence and to facilitate exchange of plants and information between the countries of the world." This society can coördinate and extend the work of all existing societies, compile statistics, promote legislation and education, prepare correspondence directories, diffuse all the latest information from the various parts of the globe, consider means of transportation, and facilitate the exchange of varieties and every commodity in which pomologists, viticulturists, florists, vegetable gardeners, and other horticulturists are interested. The Society will probably meet occasionally at the various International Exhibitions, upon which occasions, also, it can greatly aid in procuring exhibits from all parts of the world.

[1] Bot. Cent. **54:** 1. April 1893.



SCHNEIDER on SYMBIOSIS.



SCHNEIDER on SYMBIOSIS.

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THE

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In the March number will appear:

Some rare Myxomycetes of central New York, with notes on the germination of Enteridium Rozeanum, by ELIAS J. DURAND, *Cornell University, Ithaca, N. Y.*

Flowers and insects. XII, by CHARLES ROBERTSON, *Carlinville, Ills.*

On the history of a blue-green motile cell, BRADLEY MOORE DAVIS, *Harvard University, Cambridge, Mass.*

An auxanometer for the registration of growth of stems in thickness, by KATHARINE E. GOLDEN, *Purdue University, Lafayette, Ind.*

BOTANICAL GAZETTE

FEBRUARY, 1894.

Contributions from the Cryptogamic Laboratory of Harvard University. XXII.

Observations on the genus Naegelia of Reinsch.

ROLAND THAXTER.

WITH PLATE V.

In his paper entitled "Beobachtungen über einige neue Saprolegnieæ, etc.," published in Pringsheim's Jahrbücher about fifteen years since,[1] Reinsch has described and figured a peculiar fungus to which he gave the name *Naegelia* including under it two supposed species which he referred to in the text as "species I" and "species II" respectively, without further specific designation. The genus, which like Leptomitus and its allies is characterized by the division of its hyphæ into segments through the presence of successive constrictions, was based on its peculiar habit, any given hyphal segment producing distally whorls of sporangia and branching in a characteristic fashion. Although this habit is clearly indicated by the original figures and description, Cornu[2], in the year following Reinsch's publication, referred the genus unreservedly to his own *Rhipidium interruptum*, a form characterized by an extreme differentiation between a monstrously developed basal cell and the numerous branches arising from it, the habit of which, if published data may be relied upon, is quite different from that of the form under consideration. Nevertheless according to Cornu, single detached branches of *R. interruptum* are alone responsible for the creation of "Naegelia," a name, as he points out, inadmissable from its previous use in at least two instances. With this exception

[1] 11: 298. 1878.
[2] Bull. Bot. Soc. de France 1879. 226.

few references to Reinsch's genus are discoverable. Fischer in his recent work[3] retains the name *Naegelia* Reinsch, without further designation of the species, placing it under the insufficiently know genera included by him in the sub-family "APODYEÆ," with the remark that it cannot be considered identical with Rhipidium. Still more recently Schröter[4], without reference to the opinions of Cornu, assumes its distinctness and places it among the "LEPTOMITACEÆ," proposing as a substitute for the preoccupied Naegelia the modification *Naegeliella*, with one species, *N. Reinschii* n. g. et n. s., equivalent to the "species I" of Reinsch. Lastly Fritsch[5] calls attention to the preoccupation of Naegeliella for a genus of fresh water algæ and proposes a third name *Sapromyces* nov. gen. distinguishing two species, *S. Reinschii* (Schröter) Fritsch and *S. dubius* nov. sp., the last an equivalent for "Naegelia species II."

The last three references, for the most recent of which the writer is indebted to the kindness of Prof. Farlow, appear to be based wholly on the original account of Reinsch, the genus not having been observed since its first discovery. In view of the fact that this account has been discredited by the criticisms referred to, and is moreover defective in important points, the following observations may be of interest, based as they are on the examination of fresh material obtained during the past season.

The plant in question was first met with by the writer in the vicinity of York, Me., where it was found growing on a pine cone that had fallen into a wood pool of clear cold water. On this substratum the sporangiferous hyphæ were luxuriantly developed, forming a layer around it nearly a centimeter thick, but not very conspicuous from its transparency. The discharge of zoospores was repeatedly observed in this material; but no indication was seen of the presence of any form of sexual reproduction. Later in the season (September) the pool was again visited and additional specimens secured growing upon submerged fragments of branches, one of which furnished fine examples of the curious oogonia and antheridia. An examination of this material has afforded the data for the following account, but unfortunately no observations could be made

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[3]Phycomycetes in Rabenh. Kryptogamenfl. (Pilze) **1**: pt. 4. 377. 1892.
[4]Engler and Prantl. Naturl, Pflanzenf. **1**: 103.
[5]Œsterr. bot. Zeitschr. **43**: 420. 1893.

at the time either on the germination of the oospores or the details connected with the process of fertilization.

Hyphæ.—The hyphæ, as has been already stated, consist of successive segments connected by constricted portions, which may be plugged by a deposit of cellulin, or, more commonly, are without any such pseudo-septum, the contents of successive segments being, as a rule, in direct communication with one another. The primary axis originates as a single basal cell or segment which is attached by its roughened surface directly to the substratum, without rhizoidal outgrowths. It is often more or less bent and distorted but otherwise undifferentiated, except that its protoplasmic contents may be separated into isolated masses (fig. 9), through the partial obliteration of its cavity by deposits of cellulin. Above this basal segment the habit of growth characteristic of the plant begins directly. The primary axis may be continued by several successive segments, but more frequently it divides almost immediately into two or more secondary axes. This successive and more or less irregular multiplication of axes is continued from the base to the summit of the plant, any given segment producing distally one to several similar segments, the whole resulting in a copiously branched and spreading structure. In addition to the new segment or segments which may arise from the distal end of any given segment, reproductive organs, whether zoosporangia, oogonia or antheridia, are usually produced either singly or more commonly in whorls of from two to (rarely) six, zoosporangia being often associated in the same whorl with oogonia or with antheridia. Each of the organs just mentioned is separated from its parent segment by the characteristic constriction which in the case of the zoosporangia and oogonia is furnished with a cellulin plug.

Zoosporangia.—The zoosporangia, which may be terminal as well as lateral, are very variable in size and shape, usually sub-cylindrical, often elongate but sometimes oval or elliptical. The more stunted forms with short and stout sporangia (fig. 3), corresponding to Reinsch's "species II" are, as has been suggested by Fischer, merely conditions of the more typical form, resulting apparently from the lack of nutrient material in the dead twigs on which this type occurred. The sporangia are very frequently attacked by chytridiaceous parasites, and in such cases often become considerably distorted or otherwise modified, and although no resting spores were observed in any of the sporangia thus attacked, the thick walled spherical "oospores" described by Reinsch[6] as occurring, several in an "oogonium," are undoubtedly of this nature. At maturity the dense granular protoplasm within the sporangium divides into a large number of zoospores.

Zoospores. — The zoospores make their escape directly through a terminal pore without any interval of rest, swarming immediately after emergence and even while still within the partly emptied sporangium (fig. 2). They are sub-reniform in shape, biciliate and apparently monoplanetic, although this character was not definitely determined. In several instances when the discharge was observed directly, there was no indication of any process similar to that described by Cornu in Rhipidium, where the contents of the sporangium is said to be discharged simultaneously as a mass of zoospores which are then set free by the rupture of a thin surrounding membrane.

Antheridia.—The branches which terminate in antheridia arise like the zoosporangia terminally or more often laterally in whorls of several members and although often associated with zoosporangia do not occur in any of the specimens examined, on plants which produce oogonia. They are much more slender than the ordinary hyphæ, with few constrictions, often very elongate, flexuous, or often more or less irregularly spirally twisted especially just below the terminal antheridium. They may be several times branched, and are slightly constricted at such points, while the free tips, finding their way to the oogonia, become rather abruptly swollen into the antheridium proper. The antheridia are irregularly cylindrical, sometimes divided by a septum (fig. 5), and adhere closely to the oogonium, often winding partly round it, before reaching its receptive apex through which an entrance is effected by means of a beak-like process, which, pressing the wall of the oogonium inwards, perforates it at the bottom of the depression thus formed. Two antheridia (fig. 8), or even three, may be applied to a single oogonium invariably at its apex, their pollinodia penetrating side by side to the oosphere. After penetration there seems to be open communication between the oosphere and antheridium (fig. 5), but whether any interchange of contents takes place between them could not be determined from the material examined. As the oospore

[6] l. c. 11: *pl. 15. f. 4-5.* 1878.

matures the beak-like pollinodium becomes closed, its walls are greatly thickened, and its cavity sometimes wholly obliterated, so that even in old oogonia it is very sharply defined, the old antheridium also persisting and becoming somewhat thicker walled.

Oogonia.—The oogonia are either terminal or more frequently, like the sporangia with which they are often associated (fig. 4, *x*), borne laterally either singly or in whorls from the distal ends of the hyphal segments. They are nearly spherical or in the majority of cases piriform in shape, becoming covered with a brown flaky incrustation disposed transversely, and are separated from the segment which bears them by the usual constriction, which is always plugged (fig. 6) by a deposit of cellulin. Antheridia and pollinodia were present on every oogonium in the material obtained, even in the youngest specimens. In the latter the contents entirely fills the oogonium and consists of numerous large masses of refractive fatty protoplasm embedded in a more finely granular matrix. As this mass contracts to form the oospore a small amount of residual protoplasm remains unused outside it (fig. 5).

Oospores.—The oospores are always solitary in the oogonia, spherical, with very thick translucent walls which are slightly yellowish. The exospore, though slightly irregular in outline, shows no signs of any characteristic modification. Their germination was not observed.

From the above account it is manifest that the genus Sapromyces is very closely related to Rhipidium as far as can be determined from the fragmentary descriptions of this genus which are available. It is left quite uncertain by Cornu's account how much importance should be attached to the differentiation between the basal cell of Rhipidium and its branches, but if this character is as strikingly pronounced in the three remaining species as it is in *R. interruptum*, it would seem to constitute alone a sufficient basis for generic separation. Whether the differences existing in the method by which the zoospores are discharged in either case should also be considered of generic value can hardly be determined without further comparative observations. The characteristic branching and the verticillate arrangement of sporangia, relied upon by Reinsch as a basis for his genus, would seem, however, to be of comparatively slight importance.

In connection with the general habit of Sapromyces it may be noted that Reinsch in his first description,[7] where his subsequent "Naegelia species II" is described and figured as "Hyphomycetarum nov. gen." represents the sporangiferous hyphæ as arising at intervals from a "stroma ex filis tenuioribus elongatis subramosis inter muscos aquaticos intricatis formatum," but no reference to this mode of growth is made in his second paper; and since no such habit was observed by the writer, the account just quoted is presumably of doubtful accuracy.

That the species under consideration is not identical with *R. interruptum*, as asserted by Cornu, seems sufficiently manifest, since it lacks the highly differentiated basal cell, its sporangia are verticillate and its oospores are nearly smooth; while the receptive portion of the oogonium is always terminal, not "vers la base."[8] The close resemblances between the sexual organs and their action in the two genera is certainly striking: yet until further data are obtained concerning these phenomena in other genera of the sub-family, it seems not unreasonable to assume that they may have a more than generic significance.[9]

The form may be briefly characterized as follows:

SAPROMYCES REINSCHII (Schröt.) Fritsch.

Fritsch, Œsterr. bot. Zeitschr. **43:** 420. Dec. 1893.

Hyphomycetarum nov. gen. Reinsch, Contrib. ad Algol. et Fungol. 99 (Chloroph.) *pl. 14 f. 1. a–d.* 1875.

Naegelia species I et *species* II, Reinsch, Pringsheim's Jahrbücher, **11:** 298. *pl. 15. f. 1–11.* 1878. Fischer, Phycomycetes in Rabh. Kryptogamenfl. Pilze **1:** pt. 4. 377. 1892.

Naegeliella Reinschii Schröter, Engler and Prantl, Die Natürl. Pflanzenf. **1:** 103.

Sapromyces dubius Fritsch, l. c.

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[7] Contrib. ad Algol. et Fungol. 99 (Chlorph.) *pl. 14. f. 1. a–d.* 1875.

[8] Cornu, Ann des Sci. Nat. V. **15:** 30. 1872.

[9] The phenomena described by Prof. Humphrey (Saprolegniaceæ of the U. S., etc.,) in connection with the singular form described by him as *Apodachlya? completa*, do not, in the writer's opinion, afford sufficiently definite information on this point, in view of the uncertainty which exists as to their true significance. Both Rhipidium and "Naegelia Reinsch" appear to be excluded from the Leptomiteæ of Humphrey, yet it seems best on the whole, in the absence of further information, to assume the near relationship of those two genera with Leptomitus and Apodachlya, in conformity with the views of Fischer and Schroeter in the papers already cited. In this connection the close resemblance may be noted between the so-called chlamydospores of Apodachlya and the oospores of Sapromytces.

Hyphæ composed of numerous successive nearly cylindrical segments, arising one to several from undifferentiated basal segments attached to the substratum, each segment producing distally one to several similar segments, as a rule, bearing distally whorls of zoosporangia, oogonia and antheridial branches, the sexual organs on separate plants, but often associated with zoosporangia in the same whorl. Sporangia one to six in a whorl, slender sub-cylindrical to sub-clavate or stout and oval to elliptical or oblong. Oogonia sub-spherical to piriform becoming covered at maturity by a brown flaky incrustation disposed transversely, and containing a single spherical nearly smooth thick-walled oospore. Antheridia irregularly cylindrical, abruptly distinguished from the antheridial branch, sometimes divided by a septum, penetrating the oogonium always at its apex by a beak-like pollinodium. Hyphæ 7–30μ in diameter, the segments (larger) 450 × 10–15μ. Zoosporangia 22–25 × 35–200μ. Oogonia 26–40 × 32–55μ. Oospores 20–30μ.

On Viscum stems and algæ, Germany (Reinsch). On cones and twigs of Pinus in a spring, York, Maine.

Cambridge, Mass.

EXPLANATION OF PLATE V.

Sapromyces Reinschii (Schröt.) Fritsch.

Fig. 1. General habit of sporangiferous hyphæ.—Fig. 2. Whorl of three sporangia, one empty, the next before and the third during the discharge of zoospores, the axis segment turned to the right.—Fig. 3. Portion of hypha bearing stouter sporangia (Naegelia species II) before the discharge of zoospores.—Fig. 4. Hypha bearing oogonia, one of which is terminal. Also portions of two hyphæ producing antheridial branches, one of them also a zoosporangium, *x*.—Fig. 5. Oogonia and septate antheridium, a small collection of periplasm near the base and apex of the oosphere.—Fig. 6. Terminal oogonium with non-septate antheridium showing flaky incrustation of oogonium wall, a cellulin plug filling its constricted base.—Fig. 7. Empty thick walled sporangium.—Fig. 8. Oogonium showing oosphere with two antheridia attached.—Fig. 9. Three basal cells scraped from substratum, their cavities partly obliterated, that on the left giving rise to a sporangium and segments bearing oogonia and sporangia.

Fig. 1. Zeiss A, oc. 2. Figs. 2–4, 9. D, oc. 2. Figs. 5–8. D, oc. 4. Photo-reduced from ink drawings.

On some species of Micrasterias.

L. N. JOHNSON.

WITH PLATE VI.

The genus which forms the subject of these notes includes some of the largest and most beautiful of the Desmidieæ. During the past summer the writer has had an opportunity of studying an abundance of material of a number of species, including one or two rare forms. Some of the facts noted do not appear to have been previously recorded, though apparently of considerable importance. Most of the material was collected on Long Island, in several large ponds, at Cold Spring Harbor.

Probably the most interesting find was *Micrasterias foliacea* Bailey. This was very abundant in one gathering made by rinsing waterweeds. The species was first described by Prof. Bailey, in 1847, in a letter to Ralfs, and was published and figured by the latter in his British Desmidieæ.[1] It is apparently not a common species, though widely distributed. It has been reported from Burmah by Joshua,[2] from Bengal by Wallich,[3] from Java by Nordstedt. In this country Wolle found it once or twice,[4] but no one else appears to have reported it since Bailey's original discovery. Prof. Nordstedt has described[5] a variety *ornata*, from Brazil, differing from the type only in having, on the superior margin of the intermediate lobe and the inferior of the basal lobe, two small aculei.

In the material studied the cells are usually found joined end to end in long ribbon-like chains (fig. 1), though single cells are not uncommon. In some cases over a hundred cells were counted in a single filament, and the number appears to be limited only by the strength of the connection of the cells and the strain put upon it. Wallich appears to have been the

[1] The British Desmidieæ. 210. *pl. 35. f. 3.* 1848.

[2] Burmese Desmidieæ, Journal of the Linnean Soc. **21**: 636. 1886.

[3] Description of Desmidieæ from lower Bengal. Ann. and Mag. of Nat. Hist. III. **5**: 280. *pl. 14. f. 1–3.*

[4] Bulletin of Torrey Botanical Club **9**: 27. 1882. Desmids of the United States, 118. *pl. 38. f. 10, 11.* 1884.

[5] Symbolæ ad floram Braziliæ centralis cognoscendam. Particula quinta. Desmidiaceæ. Vidensk. Medd. fra den naturh. Forening i Kjöbenhaven 221. *pl. 2. f. 16.* 1869.

first to notice the union into filaments.[6] Wolle found the filaments, and states[7] that the cells are held together by the overlapping of the end lobes.

It is in connection with the form of this end lobe, and the means by which the cells are joined that the descriptions by various authors are most indefinite or confused. The figure in Ralfs' British Desmidieæ is very defective, and justifies Wallich's remark that neither Bailey nor Ralfs seems to have noticed the minute details of structure. Wallich describes the form which he found as *var.* β, but it seems scarcely distinct from the type. He describes it as emarginate, with one spine on each surface, the two being diagonally opposite. He figures a chain of three cells, but they could not possibly be joined in the manner represented by him.

Rabenhorst[8] mentions the species as one not yet found in Europe, and states that the emarginate polar lobe is bidentate on each surface. Later writers seem to have followed him, and the statement is true, as far as it goes. The best figures of the terminal lobe are given by Nordstedt,[9] but there are some points not made clear by his plate and description.

The form of a single cell is shown by the accompanying drawing (figs. 2 and 3). The lateral margins of the frond are nearly straight and parallel, and the end lobe projects but slightly beyond them. This lobe is deeply emarginate, with an almost rectangular sinus. The portion on each side of the sinus is depressed on one surface, in such a way that the two depressions lie diagonally opposite each other. This is very difficult to describe, but may be easily understood by reference to the drawings. At the base of the sinus on either surface of the frond are two tooth-like projections. These have been often noticed before, but one peculiarity seems to have been overlooked. The tooth on the side adjoining the depression is nearly twice as large as the other. An examination of hundreds of specimens shows this to be constant.

The manner in which the cells are joined in the filament may be seen from fig. 4. The lower cell is slightly separated from the next, showing the manner in which the lateral portions of the end lobes of the two fronds are dovetailed to-

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[6] Loc. cit.
[7] Desmids of the United States, 118.
[8] Flora Europaea Algarum aquæ dulcis et submarinæ. 3: 195. 1868.
[9] Loc. cit.

gether. When the cells fit closely together the projecting teeth interlock. It would be difficult to imagine a more rigid connection than this. The firmness of the union and the shape of the cells give the filaments little flexibility, and they are usually nearly straight.

Unfortunately it was impossible to work out the development of the terminal lobe, as no specimens were found undergoing division.

Micrasterias pinnatifida (Kütz.) Ralfs was another species studied. This is closely related to *M. oscitans* Ralfs, if indeed it is not merely a variety of that species. It was first described by Kützing[10] as *Euastrum pinnatifidum.* The ordinary form of cell is that shown in fig. 5, but occasionally a specimen was found with one semicell curiously distorted (fig. 6). Several cells were seen which showed this inflation of the basal lobes in one semicell, but none were found with both halves abnormal. This appears to be the same as the var. *inflata* of *M. oscitans* Ralfs described by Wolle.[11] If so his form can hardly be called a distinct variety, since we should then have specimens, one half of which was typical, while the other belonged to the variety. The most we can say is that the frond sometimes varies, with the lateral lobes inflated and produced slightly at the angles.

A species which proved in some respects the most interesting of all those studied was *M. furcata* Ag. This is one of the best known species in the genus, having been described by Agardh[12] in 1827. It is a form which is widely distributed, and has been many times described, yet some interesting peculiarities seem to have been unnoticed. The typical form of the species is shown in figs. 7 and 8. The former is from a Long Island specimen, while the other was collected on the other side of the Sound in Connecticut, but not fifty miles distant. One peculiarity of Connecticut specimens was their small size. The average diameter of thirty specimens measured was 120μ, the extreme measurements being 108μ and 132μ. De Toni[13] gives 113–205μ as the range of variation of the species. The Long Island specimens were larger, the typical ones averaging 133μ, with extremes of 120 and

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[10] Phycologia Germanica 134. 1845.
[11] Bulletin of Torrey Botanical Club. **6:** 122.—**8:** *pl.* 6. *f.* 5. 1881.
[12] Flora **10:** 643. 1827.
[13] Sylloge Algarum omnium hucusque cognitarum. **1:** 1114. 1889.

156μ. In another respect the latter are remarkable. The typical form, as is well known, has each of the four lateral lobes deeply bifid, but such specimens are not numerous in this material. The cell shows a decided tendency toward a form with simple lobes (fig. 14). Scores of specimens were examined of which no record was made, but of thirty taken at random which were measured, eleven were typical, two had one simple lobe, five had two, two had three and the same number four, three had but two typical lobes each, three had but one, while two were of the form shown in fig. 14, with all the lobes simple. Some of these varieties are shown in figs. 9–13. Sometimes all the abnormal lobes are in one semicell, while the other is normal, but quite as often some lobes of each are simple, and these may be on the same or opposite sides of the frond. A curious and rather puzzling fact is that the lobes nearest the base of the semicell show the greatest tendency to this variation. If there are not more than four simple lobes these are almost invariably the basal ones. Only one exception to this was found among all the specimens examined.

Another noteworthy fact is that the abnormal forms are almost invariably larger than the typical. Of the thirty specimens measured the eleven typical ones averaged 133μ, while the others averaged 163, and the average of those having over four simple lobes was 182, with extremes of 165 and 200μ. Only two abnormal specimens measured less than 140μ. Often the difference could be seen in a single cell, the varying half being decidedly larger than the other.

In the material collected in Connecticut, only a week or two after the former collection, these variations were very infrequent, but they were found occasionally. Of thirty specimens all but three were of the typical form. Of the three, one showed one semicell of the typical form, while the other was of the extreme form, with all the lobes simple.

Turner has described and figured a variety *decurta*[14] of *M. furcata* Ralfs which seems to be this simple form. He says of it that it is "a strange and apparently abnormal form. Only two semicells seen, of which one possessed a curious double lobelet." His material was from Watertown, N. Y.

It is hardly necessary to call attention to the close re-

[14] On some new and rare desmids. Jour. Royal Micr. Soc. **5:** 936. *pl. 16. f. 10.* 1885.

semblance between the simplest form here described and Mr. Wolle's description and figure[15] of *M. pseudofurcata.* The chief distinction given by him for this species is that it has "only half as many lateral arms" as *M. furcata.* The original figure of *M. pseudofurcata* Wolle, in the Bulletin of the Torrey Botanical Club is almost exactly like fig. 14, and probably represents the same form.

In this connection it is of interest to note Wolle's description of *M. furcata* var. *simplex.*[16] From this it will be seen that he collected and examined in Florida a series of forms showing all possible gradations from a form with two simple lateral arms on each side to one with but one simple lobe on each side of the semicell. He himself calls attention to the resemblance of the former to *M. pseudofurcata* Wolle, and says that it needs further examination.

Combining these facts it seems to the writer that we are justified in no longer recognizing *M. pseudofurcata* Wolle as a distinct species, since a whole series of forms has been found connecting it with *M. furcata* Ag. while the Florida forms described by Wolle connect it with the simple three lobed form. The varieties, *decurta* Turner, and *simplex* Wolle, simply represent forms in this series of variations, and not true varieties. We must then regard *M. furcata* Ag., as an extremely variable species, and our description must be modified to include forms with the lateral lobes two or four, simple or bifid.

No cause could be discovered for the greater variability of the Long Island specimens unless it may be the lower temperature of the water, the Connecticut specimens being from a shallow pool, where the water was quite warm. The larger size of the Long Island forms would perhaps indicate better conditions for vigorous growth.

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EXPLANATION OF PLATE VI.

(All figures reduced one-sixth in engraving.)

Fig. 1. Portion of a filament of *Micrasterias foliacea* Bailey. × 200.—Fig 2. Single cell of same. × 400.—Fig. 3. Vertical view of frond, showing form of terminal lobe. × 400.—Fig. 4. Series of three cells, showing manner of joining. × 400.—Fig. 5. *Micrasterias pinnatifida* (Kütz.) Ralfs. × 400.—Fig. 6. Same, showing abnormal semicell. × 400.—Fig. 7. *Micrasterias furcata* Ag., typical form: Long Island. × 160.—Fig. 8. Same, Connecticut. × 160.—Fig. 9-13. *M. furcata* Ag. showing variations. × 160.—Fig. 14. Same; form with lateral lobes all simple. × 160.

[15] Bulletin of Torrey Botanical Club. **12:** *pl. 51. f. 6,* 7. 1885.
[16] Freshwater algæ of the United States 40. *pl. 59. f,* 6, 7. 1887.

On the development of the bulb of the adder's-tongue.

FREDERICK H. BLODGETT.

WITH PLATES VII AND VIII.

Hundreds of small plants of the adder's-tongue, or spring lily *(Erythronium Americanum* Ker.) are found in the spring with the bulbs less than five inches below the surface of the soil, each bearing a single leaf and no flowers, while comparatively few plants bearing two leaves and a flower each are found, and bulbs of these are at depths varying from five to nine inches.

The question has been raised as to the method by which the mature bulbs reach their great depth.

Early in March, 1893, I helped to fill a window box with surface mold taken from the woods, containing small bulbs of the *Erythronium*, apparently seedlings. These bulbs, which were found less than three inches from the surface of the ground, developed each its single leaf (fig. 1), which died down in a month or so. When the earth was removed from the box to make room for other plants, the bulbs were found to have developed runners with bulb-like thickenings at the ends (fig. 7). Having thus gained a clue as to the way in which the bulb of a flower-producing plant is formed at the depth at which it is found, many other plants were examined in various stages of development. The bulbs of the plants which produced flowers this year are called flowering bulbs in these notes, in distinction from those of the younger plants which are termed seedlings or secondary bulbs according to size and age.

The runners start from the bottom of the bulb, but vary both in length and direction of growth, being from two to nine inches long, and ranging from perpendicular to nearly or quite horizontal (figs. 2–5). As the supply of nourishment in the parent bulb is exhausted, the tip of the runner thickens into a secondary bulb, which sends out rootlets from the upper part (fig. 11), and then the runner is absorbed, leaving, in the cases examined, nothing but a dry and empty husk of the parent bulb and runner. These secondary bulbs later in the season lose their fleshy rootlets from the upper part of the bulb and send out the fibrous roots from the base.

The number of runners varies from one to three in the plants examined, and they grow in different directions. These runners are from two to nine inches long, so that if they grew vertically the bulb might be formed at the depth of the flowering bulbs, but they run obliquely more frequently than vertically thus leaving the secondary bulbs nearer the surface than the mature ones. The secondary bulb, after reaching the depth of the flowering bulb, does not always blossom the next spring, for bulbs with six inches of soil above them have been found with one leaf each (fig. 8).

On May 30th the leaves had in most cases disappeared so that it was with difficulty that a few plants with fruit and decayed leaves were secured, while the soil was filled with the fleshy runners and newly formed secondary bulbs. These runners were often found on the surface of the soil, protected by the mulching of leaves. In such cases the new bulb is but very little, if at all, deeper in the soil than the parent.

The flesh of the mature bulb is firm and white, and leaves a white coating of starch on a knife with which it has been cut. When crushed between the fingers, it becomes sticky as it dries. The starch grains are about half the size of those of the potato, measuring from $.010^{mm}$ to $.042^{mm}$ in length and from $.007^{mm}$ to $.035^{mm}$ in breadth. The mature bulbs do not produce runners.

Plants frequently grow so close together that they indent each other, and adhere strongly one to the other, but no break in the skin at the point of contact was seen although looked for carefully. These clusters of bulbs are formed by buds which the mature bulb sends off from its base as was seen on November 4th, and in a very large one on November 30th. There was no runner present, but in other respects the bud corresponds to a secondary bulb, and comes to maturity in close contact with the parent. This budding is carried on for an indefinite period, two buds of different sizes sometimes being formed on the same bulb.

Plants examined in July, on September 18th, and on October 30th, showed no new developments except that the runners and the parent bulb had both disappeared save traces of the epidermis.

On November 1st, I examined, without a lens, a number of small bulbs which had been taken a couple of days before from just below the surface of the soil, in the same place in which the runners were so plentiful on May 30th, and where blossoms had been abundant earlier. These small bulbs were not more than a quarter of an inch long, and, mistaking them for seeds, they were cut open in search of the embryo. They proved to be bulbs, for within each there was a sprout formed of the single leaf, extending the length of the bulb, and root fibers were clustered at the base.

These small seedlings had a loose husk or epidermis similar to that of the older ones, but not quite so dark in color. The mature bulbs had not softened since their time of blossoming early in spring. They were as firm on November 1st as on April 8th.

On November 4th a microscopical examination of sections cut from bulbs of various ages was made. A vertical section of a mature bulb showed a sprout of a yellow color, made up of several layers running up through the flesh near one side (figs. 21, 22). The outer of these layers was formed by the two foliage leaves enclosing the bud of next spring's flower. This flower bud was more than half as long as the whole bulb and its parts were well advanced. The perianth was nearly colorless, but the leaves were quite yellow. The stamens were nearly three-eighths of an inch in length, of which the anther was more than half. The anthers were filled with pollen, the grains of which were four times the size of the starch grains. The pistil was five-sixteenths of an inch in length, the ovary being one-eighth of an inch long. The projections on the placentæ from which the ovules are developed were seen and showed a dark center.

After removing the husk, the tip of a fresh specimen was seen to be made up of two modified leaves, or leaf scales, one completely surrounding the other except at the tip where the sprout and inner scale push through. The pressure on the edges of this opening compresses the flesh on the one side of the tip but makes it spongy on the other. These two tips, one within the other, gave the impression that the root is a true bulb, being formed of modified leaves, which was afterwards confirmed by studying the sections, and by comparison of the definitions of corm and bulb, and the examination of examples of each.

A section cut from the bulb a quarter of an inch below the tip showed the sprout to be composed of concentric layers which are the foliage leaves enclosing the perianth and other parts of the bud. The epidermal cells were distinguishable at the middle of the outer leaf, which completely surrounds the inner one and overlaps, but the inner one does not meet around the enclosed flower-bud, as is shown in fig. 23. This is the character of the bulb scales, the outer one overlapping at the edges, which in its altered growth have united so that there is formed a continuous layer of very starchy flesh, which varies in thickness from one-sixteenth to three-sixteenths of an inch. The inner leaf and the inner scale agree in only partially surrounding the parts within it, and each is thinner than its outer fellow (fig. 18).

A second section showed each of the anthers to be composed of four pollen chambers, united by a delicate structure. The partition between the two in each of the lateral pairs of anther cells was thinner than that which separated these lateral pairs (fig. 24). In the later growth of the flower the thinner of these sets of partitions is broken through and thus each lateral pair becomes a single cavity forming "two-celled anthers" described in the manuals. In the center the three lobed style is seen in section. It shows the tube in each lobe through which the pollen is enabled to reach the ovules (fig. 23). These tubes of the style begin to expand, in a third section, into the cells of the ovary. The lateral pairs of anther cells have drawn away from each other and the partition separating the cells of each pair is thinner than in the previous section.

The edges of each sepal were turned inward at almost a right angle and indented the petals deeply, forming a groove on either side of the midrib of each petal. The petals in turn bent their edges inward, forcing them between the lateral pairs of anther cells on the alternate stamen (fig. 23). In the fourth section there is a more marked yellow tint to the perianth than before noticed.

The ninth section shows the line which marks the surfaces of the leaves which through modification form the pistil. On the involute margins of these leaves, forming the placentæ, the ovule masses appear, which are seen to be outgrowths from the edge of the leaf itself (fig. 25).

In the tenth section the union between the filaments and the midvein of the petals was clearly seen. The anthers do not adhere to the filament for their whole length as one of the filaments dropped away from the anther cells in this section.

An external bud, at the base of the bulb, contained a single leaf in a state of development corresponding to that of a bulb a quarter of an inch long. The upper surface of the leaf was marked by a line extending partly across the sprout.

On examining the bulbs a quarter of an inch long, from the seeds of last spring's flowers, the leaf was merely a round yellowish body having a line extending nearly across it, showing where the upper surface of the leaf was to be. In a bulb half an inch long, the leaf is convolute and its surfaces are free from each other. In an intermediate bulb, the leaf was convolute above and conduplicate near the base.

On November 29th a large bulb was found which had a bud almost entirely separated from the parent bulb, and there was also a bud forming at one side which had the sprout well developed but the line of separation was indicated only by a notch on one side. A similar bulb examined December 6th is shown in figs. 17 and 18.

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EXPLANATION OF PLATES VII AND VIII.

The figures of Plate VII are taken from blue prints which were made from pressed specimens. They are reduced a little more than one-half.

Fig. 1. Seedling plant in leaf.—Fig. 2. Seedling with growing runner.—Fig. 3. Seedling with runners started in opposite directions.—Figs. 4, 5. Runners in active state. Fig. 4 is 9 inches from base to tip, in a straight line; fig. 5 is 8 inches from base of longer runner to its tip, omitting bends.—Fig. 6, 7. Runners developing secondary bulbs.—Fig. 8. Plant with six inches of soil above the bulb, bearing one leaf and no flower.—Figs. 9, 10. Secondary bulbs formed at the ends of runners. The longest runner of fig. 9 is 7.25 inches long; the longest in fig. 10 is 7.75 inches long.—Fig. 11. Runner having rootlets from upper part of the secondary bulb. This runner grew at nearly the same angle as the one in fig. 4.—Fig. 12. Mature plant bearing two leaves and a flower.

The figures of Plate VIII were drawn directly from the specimens. The sprouts had developed so rapidly that some of the points seen on Nov. 4th had disappeared to a considerable degree, having grown from ¼ to ¾ of an inch in the month. The figures were made during the week ending Dec. 9th, from bulbs dug Nov. 29th.

Fig. 13. A seedling bulb.—Fig. 14. Secondary bulb showing sprout protruding.—Fig. 15. Mature bulb showing sprout, a small bud, *a*, and a larger bud, *b*, under the epidermis or husk.—Fig. 16. Mature bulb with one bud nearly separated, *b*, and another less advanced, *a*.—Fig. 17. Mature bulb with bud nearly independent of parent at *b*, and a second less mature one at *a*.—Fig. 18. Cross section of fig. 17; *l*, the bases of the leaves sheathing the stem, *sm*; *l'*, the single convolute leaf of bud *b*. The heavy black lines in this and the following figures are empty spaces between the flesh of the bulb and the sprout.—Figs. 19, 20, 21. Vertical sections of 13, 14, 15, respectively.—Fig. 22. Vertical section of mature bulb showing the flower; *p*, perianth, the tips of its lobes enclose the stamens, *st*, the style and stigma, *s*; *o*, ovary; *sm*, stem; *l*, bases of foliage leaves.—Fig. 23. Cross section of sprout showing the four celled anthers, the style, perianth and leaves. The anthers are distorted by pressure in the bud. ×3.—Fig. 24. Cross sections of single anther. ×32.—Fig. 25. Section of ovary showing the lines which indicate the surfaces of the leaves from which it is developed, and the formation of ovules on the margins of these modified leaves. ×35.—Fig. 26. Section of older ovary. ×20.

Noteworthy anatomical and physiological researches.

The function of the secondary tissues in arborescent monocotyledons.[1]

The secondary growth in the aerial and terrestrial stems of the arborescent monocotyledons has already been studied by various authors, as for instance: Karsten, Millardet, Mirbel, Nägeli, Röseler and Wossidlo[2]. These investigations have been mostly restricted to the mere origin and development of the secondary meristem, while the study of the function of this tissue has been rather neglected.

The few authors, in whose works mention has been made of function, agree, however, in considering the secondary tissue as giving rise to a supporting apparatus for the stem, which often attains a considerable size in the Liliaceæ, for instance, *Dracæna* and *Cordyline*.

The structure of monocotyledons in which a secondary growth takes place exhibits two characteristic cases: the cells of the secondary tissues may become lignified as in *Dracæna*, *Cordyline* and *Lomatophyllum*, or their membranes may remain thin. There is no doubt that the first case shows a function of support, while in the other case an entirely different and highly important function is attributed to this thin-walled parenchyma. In *Cohnia flabelliformis*, for instance, the rhizome consists almost entirely of unlignified secondary parenchyma. These cells contain a considerable quantity of a fatty oil, which constitutes an important nutritive deposit especially for the development of adventitious buds. It is otherwise rare to find such deposits of fatty oils in the rhizomes.

A similar thin-walled parenchyma of secondary origin was also observed in *Yucca gloriosa*, especially in the rhizome; the cell-content was in this case a kind of sugar. *Dioscorea sativa* shows the presence of broad layers of secondary tissues, which form the principal element of the rhizome, as described by De Bary[3] as characteristic of other Dioscoreaceæ. The cells contained here large deposits of starch.

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[1] De Cordemoy, Sur le rôle des tissus secondaires à réserves des monocotylédones arborescentes (Comptes Rendus **117**: 132. 1893).

[2] For citations see the original paper.

[3] De Bary, Vergleichende Anatomie der Vegetationsorgane der Phanerogamen und Farne 640. Leipzig, 1877.

The secondary mestome bundles, which have originated from the secondary parenchyma, serve naturally as carriers of such substances as are useful to the plant. This is very conspicuous in *Dioscorea*, where starch grains form heavy masses around the mestome bundles; this starch becomes transformed, however, upon the renewed growth in the spring. At this time it takes a reddish-violet color with iodine, and the grains near the mestome bundles have decreased in size and look as if they were partly digested. THEO. HOLM.

The role of the pericycle in the root of Dracæna marginata.[4]

The roots in certain monocotyledons show an increase in diameter, a fact that has been observed in *Aletris fragrans*, and in some species of *Dracæna*, e. g., *D. marginata*, *D. reflexa*, *D. fruticosa*, *D. Draco* and *D. rubra*. It has been demonstrated in most cases that the secondary parenchyma, to which this increase in diameter is due, is of a pericyclic origin. The cells of the pericycle divide tangentially and give rise to a secondary tissue with centrifugal development; some of these cells begin, thereupon, to divide in various directions and produce procambial strings, which soon become differentiated into a corresponding number of secondary mestome bundles. The central cylinder, therefore, is the structure which undergoes an increase in diameter.

Some cases have been recorded, however, where similar secondary formations were not of pericyclic origin, but developed in the bark. This fact was observed in *Dracæna reflexa* and *D. marginata* by Morot.[5] The pericycle had in these cases, nevertheless, preserved a certain activity, showing a few divisions of its cells.

Some analogous observations have been made by the author, who has studied the structure of the roots of *Dracæna marginata*. All the roots showed the presence of secondary formations in the bark itself. The pericycle had to a certain extent been multiplied, and had here a true mechanical function, not previously noticed. A transverse section of one of these roots, in which there is not yet any sign of secondary formations, shows an endodermis, the cell walls of which are

[4]DE CORDEMOY, Du rôle du péricycle dans la racine du *Dracæna marginata*. Bull. de la soc. bot. de France, **40**: — 1893.

[5]LOUIS MOROT, Recherches sur le péricycle. Ann. d. sc. nat. Bot VI. **20**: 217. 1885.

thickened so as to constitute a U-endodermis. Inside this is a simple pericycle, where some cells show a tangential division; the groups of leptome and hadrome border on this pericycle, as in other roots. But a root measuring about 72^{mm} in diameter shows that these tangential divisions of the pericycle do not produce any secondary parenchyma. There is, however, a secondary parenchyma present, but this is located in the bark, representing a secondary bark, of which the primary layers rest immediately upon the endodermis. The secondary meristem, from which these tissues have originated, has been formed in the innermost layers of the primary bark. When this secondary parenchyma developed in the bark, the pericycle commenced to show tangential divisions in various places, especially where it consisted of from seven to eight rows of radially arranged cells.

This increase of the pericycle causes a pressure from the interior to the exterior; thus the endodermis becomes ruptured in certain places, and a communication opens between the central cylinder and the cortical zone. The cells of the pericycle come to be, in this way, in contact with the secondary bark. These pericycle cells show, thereupon, a beginning sclerosis of their membranes.

The result of this investigation is that although the secondary formations in the root of *Dracæna* have originated from the bark, the pericycle may, nevertheless, show a certain activity, so as to produce a pressure from the interior to the exterior, by which action the endodermis becomes ruptured. A communication is thus established between the two conducting systems, the primary and the secondary.

THEO. HOLM.

Vegetable ferments.

There is hardly any branch of physiology which claims our attention more than that including the ferments. In the animals, as well as in the plants, their action is so important that it is impossible to form any opinion of the act of nutrition unless we keep a steady look at the ferments. Much has not been done yet, but it is a very desirable work that has been done by Professor J. R. Green,[6] namely, "to give some account of the various vegetable enzymes now known to ex-

[6]On vegetable ferments. Annals of Botany **7:** 83–137. 1893.

ist; to review their general properties, mode of action, and composition." He has also cited the literature of the subject extensively, for which the original paper must be consulted.

I. CARBOHYDRATE ENZYMES.

1. *Diastase.* Baranetzky found it in many plants, and it has been made the object for a special study by Kjeldahl, Brown and Morris, and others, especially in barley-seeds where it appears at an early stage of development and where it is found in the part of the endosperm adjoining the embryo, preparing the food for the latter out of the starch present in the grain. In leaves, its existence was known, and its function thought to be that of converting starch into sugar. Wortman, however, did not ascertain its existence, whence he concluded that the protoplasm had, itself, this function. Vines and St. Jentys gave afterwards new evidence of its presence and function. This so-called translocation-diastase will dissolve starch-grains without corrosion, has an optimum-temperature of 45°–50°C., and liquefies starch-paste slowly. Another form, viz., the diastase of secretion, was found by Brown and Morris, and Haberlandt; it is formed shortly after the beginning of the germination in the epithelium of the scutellum, dissolving starch-grains by corrosion. It liquefies starch-paste rapidly and has its optimum temperature at 50°–55°C. The final product of the transformation is apparently maltose, the intermediate members being unknown.

2. *Inulase.* In Dahlia, Helianthus tuberosus, and Inula Helenium, the reserve-material of the tubers is inuline, and a corresponding ferment, inulase, has been found.

3. *Invertase.* This ferment inverts cane-sugar into dextrose and levulose. It has been found in an extract of malt, in leaves and buds by Kossmann, in pollen-grains, in petals of Robinia Pseudacacia, in the embryo of germinating barley by Kjeldahl and O'Sullivan, and in several of the Saccharomyces, in Fusarum, and in Aspergillus niger.

4. *Cyto-hydrolytic enzymes.* These transform cellulose, where this is present as a reserve material, as in the seeds of Phœnix dactylifera. M. Ward has found that a similar enzyme is present in the hyphæ of Botrytis which was growing in the tissues of Lilium candidum. Also in germinating barley it has been found by Brown and Morris.

II. GLUCOSIDE ENZYMES.

1. *Emulsin or synaptase.* In certain species of Amygdalus, Cerasus and Prunus emulsin decomposes the amygdalin,

forming prussic acid and sugar: $C_{20}H_{27}NO_{11}+2H_2O=C_6H_5COH+HCN+2(C_6H_{12}O_6)$. Its place in the bitter almonds was studied by Johannsen and Guignard; the latter found it in special cells in the parenchyma of all parts of the plant; the greatest amount was, however, found in the seeds.

2. *Rhamnase.* In seeds of Rhamnus infectorius, it decomposes the glucoside xanthorhamnin into rhamnin and sugar.

3. *Erythrozym.*

III. PROTEO-HYDROLYTIC ENZYMES. Ferments of this group decompose proteids.

1. *Pepsin* is the most notable of these. Its presence in the fluid excreted by Drosera, Nepenthes, Dionaea, Pinguicula, Sarracenia, etc. is well known, as well as the theories based upon these facts, and also the lately announced Russian experiments.[7] A peptonizing ferment was also found by Krukenberg in Æthalium septicum.

2. *Tryptic enzymes.* In Carica Papaya one of these, the papain, has been observed; in the fruit of the pine-apple, Chittenden found another enzyme of this group. In the seeds of the vetch Gorup-Besanez found an enzyme, and also in the seeds of flax, hemp, and barley, while Green worked with the lupines. How these ferments work *in the plants* has not yet been satisfactorily investigated.

3. *Rennet.* In Galium verum, a substance was long since noticed which was able to coagulate milk. Afterwards, an enzyme was found in Pinguicula vulgaris by Linné and Darwin, in Withania coagulans (seeds) by Lea, in Datura Stramonium, Pisum sativum, Lupinus hirsutus, and Ricinus communis, by Green. We may add that rennet has also been isolated from bacteria by Conn.[8]

IV. GLYCERIDE ENZYMES. Such are able to decompose oils or fats. Müntz was the first who paid attention to the splitting up of the oils in germinating seeds. In Ricinus communis an enzyme was found; it decomposes fats into fatty acids and glycerin. In many other seeds of this group similar enzymes have been noticed.

In many fungi and bacteria, enzymes are present. Five distinct enzymes were found by Vignal in the Bacillus mesentericus vulgatus: diastase, invertase, rennet, and a proteohy-

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[7] BOT. GAZ. **18:** 105. 1893.

[8] Science (New York), 1892, 253. Fifth Report of the Storrs Agr. Exp. Station, 1892. 106.

drolytic as well as a pectic enzyme. The enzymes of the pathogene bacteria are subjects of a great deal of study, and much has been written on them.

Zymogens ("mother of ferment") are known from the animals. They have been found in plants, such as Nepenthes, in resting wheat grains, in the irritable cells of Dionaea muscipula, and in others.

A discussion of the constitution of the enzymes, the many theories with reference to their mode of action, etc., forms the conclusion of Professor Green's solid work.—J. CHRISTIAN BAY.

Equiseta in the carboniferous.[9]

It is now about nine years since MM. Renault and Zeille[10] published from the Commentry basin, upper coal measures, a description and figure of an Equisetum stem about 12^{cm} long and 4 or 5^{cm} wide, showing thirteen nodes which are provided with unquestionable toothed sheaths in the arrangement characteristic of *Equisetum*. This *Equisetum Monyi* constitutes perhaps the first really good evidence of the presence of the genus in the carboniferous, though a number of unsatisfactory species of *Equisetites* were published years ago by older authors. This evidence is now essentially corroborated by the description and illustration, by Mr. Kidston, of several fructifications which, although the under sides of the hexagonal sporangiferous shields with the sporangia cannot be seen, are so nearly identical in every character with the cones of *Equisetum limosum* Sm. as to leave almost no room for doubt as to the existence of the actual genus as far back in geological time as the carboniferous. The specimens are from the shale in the Barnsley thick coal, in the middle coal measures of Yorkshire, England.—DAVID WHITE.

The mechanics of growing plants.

While Charles Darwin, Krabbe, Clark and others have brought to light many important facts bearing upon the work accomplished by plants in growth and movement, yet to Dr. Pfeffer must belong the credit of the formulation of the gen-

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[9] ROBERT KIDSTON; On the occurrence of the genus Equisetum (*E. Hemingwayi* Kidston) in the Yorkshire coal-measures. Ann. and Mag. N. H., F. 1892. 138-141.

[10] Comptes Rendus, 5 Ja 1885. Études sur le terr. houill. Commentry.—Flore fossile 2: 394. *pl.* 57. *f.* 7. St. Etienne, 1890.

eral principles governing the performance of work, and the establishment of the relations between inner and outer manifestations of energy in the growing plant.[11] The subject received its first important consideration from him in his "Pflanzenphysiologie" (**2**: 1. 1882), and later an exhaustive and critical discussion in his "Energetik der Pflanze" of which the memoir before us is an extension, together with the results of a series of close experiments on roots, seedlings, grasses, and algæ.

Plants were encased in gypsum casts rendered isosmotic by an admixture of nitrate of potassium or sulphate of magnesium. Others were enclosed in clay and in gelatine. While thus held firmly, longitudinal and transverse pressures delivered by various organs were measured directly by simple and ingenious dynamometers constructed for the purpose.

The results of these experiments are of the deepest interest. In the growing tips of roots of *Faba vulgaris* an elongating pressure of five to ninteen atmospheres was measured. In roots of *Zea mais* a similar force of nine to twenty-four atmospheres was observed; in *Vicia sativa*, eight to thirteen atmospheres, and in *Æsculus hippocastanum*, six atmospheres. The transverse pressure delivered by roots of *Faba vulgaris* amounted to two to six atmospheres; by *Zea mais* 6.59 atmospheres.

The power of geotropic curvature was found to reside in the nodes, internodes and basal portions of the leaves in various species of the grasses. The turgor producing this curvature amounted to six to thirteen atmospheres.

In the case of transverse tensions, however, the total pressure was far greater than that exerted by the longitudinal tensions. All externally expressed tensions are set up in the same manner as the tissue tensions. In this connection a large amount of valuable matter concerning turgor, and its methods of analysis by plasmolysis are given.

Perhaps the most remarkable facts recorded in the paper are the accounts of experiments in which Spirogyra, Chara, and Nitella were grown for several weeks embedded in the plaster casts, without injury to their organization.

The notable lack of literature on the subject matter enhances if possible the value of this and the preceding memoir.

[11] W. PFEFFER: Druck- und Arbeitsleistungen durch wachsende Pflanzen. Abhandl. d. math.-phys. Classe d. Königl. Sächs. Ges. d. Wiss. **20**: — no. 3. 1893.

Taken together they form a comprehensive reference text, which by its lucid exposition, and simple methods of experimentation, will be useful as a laboratory manual in directing further research on this phase of plant life. As such it is available to any worker with even an elementary knowledge of the subject. The matter has a twofold importance; because of its connection with the physiology of the plant, and because through it only are the facts of mechanique capable of their true interpretation.—D. T. MACDOUGAL.

CURRENT LITERATURE.

The Buitenzorg Botanic Garden.

Botanic gardens are not common in America, and moreover their usefulness is not generally recognized. From an economic and commercial point of view they are not considered of sufficient value to pay for their maintenance. Even from the purely scientific side of the subject the opinion is by no means unanimous that they are worth as much as they cost. There are good and sufficient reasons for this state of affairs, which, however, need not be rehearsed in this connection. Recently some indications of a change in popular and scientific sentiment have been apparent, encouraged especially by the prominence and acknowledged success of the Missouri Botanic Garden. Probably the botanical public has never been more ready to learn about botanic gardens, their history, their aims, their resources, than now. The recent appearance of the memorial volume[1] commemorating the seventy-fifth anniversary of the founding of the botanic garden at Buitenzorg, Java, is therefore opportune.

The memorial volume was first published in Dutch, but has been translated into German, and a dozen handsome views of the garden added, for the convenience of European botanists, a form that will also, no doubt, be acceptable on this side of the Atlantic. The volume contains, as an introduction, the anniversary address of Dr. M. Treub, the director, upon the "value of a tropical botanic garden," and also very interesting articles giving a history of the garden, description of a stroll through the garden, an account of the herbarium and museum, a descriptive and classified list of the scientific investigations conducted at the garden, and an account of the more important economic plants cultivated, as well as several lists of plants, books, visiting investigators, etc., prepared by the several members of the garden staff. Nearly the whole volume will prove of much interest to botanists in general, quite apart from its local application.

The seventy-five years (now nearly seventy-seven years), of existence of the Buitenzorg garden have seen great changes in its fortunes. Founded in 1817 to secure, test and distribute seeds and cuttings of useful plants to the Dutch colonies, it flourished for nearly a decade, then for a dozen years was reduced to inactivity and nearly abolished

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[1] Der botanische Garten, "'s Lands Plantentuin," zu Buitenzorg auf Java: Festschrift zur Feier seines 75-jährigen Bestehens (1817–1892). Leipzig. Wilhelm Engelmann, 1893. Roy. 8vo. 426 pp. 12 photogravures. 4 maps. M. 14.

through political influence. In 1830 a young gardener, twenty years of age, Mr. J. E. Teijsmann, without scientific training, but with great energy, perseverance and sound judgment, was placed in charge. For more than half a century he directed the fortunes of the garden, raising it from a state of lethargy to one of usefulness, and causing it on the whole to make wonderful development, although through political and other misfortunes it several times met with disheartening reverses. In 1844 the large and important herbarium was ordered to be sent to Holland, to the Royal Herbarium at Leyden, a loss to the garden still felt in the study of the native flora, although the present collection is very large.

The library possesses about 2,400 volumes, more than half being exclusively botanical, also 165 periodicals. Large collections of vegetable products of various kinds form an attractive museum for study and instruction. The garden covers 144 acres, and abounds in beautiful landscape effects, noble trees, and a wealth of tropical plants, numbering over 9,000 species. The principal buildings are the museum, the agricultural-chemical laboratory, the pharmacological laboratory, the studio for photography and engraving, the large botanical laboratory (where visiting botanists work), and the offices and small botanical laboratory. The staff consists of fifteen members beside the director; the labor of caring for the garden is performed by about 200 native Javanese.

Although the garden was founded and has been maintained for practical ends, it has of late years attained a high reputation for its scientific researches, partly published in the *Annales* of the garden, and partly elsewhere. The present management has provided facilities for visiting botanists, the laboratory for their use being opened in 1885, and encourages the freest use of the same. The visiting list is already long, including many well known names, such as Professors Solms-Laubach (Strassburg), Goebel (Munich), Tschirch (Berlin), Schimper (Bonn), Stahl (Jena), Haberlandt (Graz), and others. The favorite time for a visit appears to be from November to March, although some visitors are likely to be found in the laboratory at all times of the year.

This notice is given for the purpose of calling attention both to a valuable and attractive book, and to a tropical laboratory where American investigators will find a hearty welcome and rare facilities for study of vegetation under the tropics.

Botany of the Death Valley Expedition.

This report not only deserves notice for its own sake, but also as representing the result of the first attempt by the government to conduct a biological survey from the botanical standpoint. The result certainly indicates the great advantage of having trained botanists as well as collectors in the field. Compared with the usual bare lists, with such meager information as collectors have made possible, the present report belongs to an entirely different class. Mr. Coville is known to be very systematic, and the parts follow each other with all the precision and fulness of an encyclopedia. The summary shows that the catalogue contains 1,261 species and varieties, forty-two of which are characterized as new. Two genera are proposed as new, viz.: *Orochænactis* (founded upon *Chænactis thysanocarpha* Gray) and *Phyllogonum* (a peculiar member of the Eriogoneæ). *Fremontodendron* is proposed as a substitute for *Fremontia* under the rule of homonyms. As interesting as is the catalogue of species, with its very full and very valuable notes, the most significant part of the report is that which deals with the principles of plant distribution in general, the distribution of plants in southeastern California, and the characteristics and adaptations of the desert flora. The treatment of the general subject of distribution is best indicated in the following summary given by the author:

"To sum up, the six ultimate factors in the distribution of vegetation are heat, light, water, food, air and mechanique. These factors are variously combined in actual fact into such conditions, among others, as geographic isolation, latitude, altitude, rainfall, soil, fires, proximity to large bodies of water, slope exposure, and presence of forests."

Attention is called also to the fact that trees and shrubs are the best zonal guides, as illustrated by the Larrea zone (Lower Sonoran), in which occurs a Grayia belt. In treating of the distribution of plants in S. E. California, the desert plants east of the Cordilleran system are considered, the plants of the high Californian Sierras (which were found to show as close an affinity to those of the Rockies of Colorado as to those of the Oregon and Washington Cascades, which is taken to indicate a former boreal communication across Nevada and Utah), and those of Death Valley proper. The last show, what was to be expected, a northern extension of Sonoran and Chihuahuan types. The characteristics and adaptations of the desert flora

[1]Coville, Frederick Vernon:—Botany of the Death Valley Expedition. A report on the Botany of the Expedition sent out in 1891 by the U. S. Department of Agriculture to make a biological survey of the region of Death Valley, California. 8vo. pp. 318, with 21 plates and map. Contributions U. S. Nat. Herbarium, Vol. IV, 1893.

is a subject so full of interest that it cannot fairly be treated in our limited space. There is presented the source and distribution of moisture, the conservation of moisture, the temperature and seasons of the region, a classified list of the desert plants, and general and special adaptations. Under general adaptations the absence of trees is noted, and the size, spacing, and form of the characteristic shrubby vegetations in their relation to each other and the struggle for moisture. The marked special adaptations are also to be found chiefly among the shrubs, as the plants "subjected to all the seasonal changes of many years." Naturally these special adaptations have to do chiefly with modifications for reducing transpiration, and also rapid radiation, and quite a list of plants is given with the modification in each case. This part of the report, however, deserves careful reading, and the whole stands as the most important one of the Contributions of the National Herbarium yet issued. It is also a matter of great congratulation that the twenty-one plates accompanying the report are of the best quality and not the rough ones that have been too common in the "Contributions."

A Flora of French Polynesia.[1]

Any account of the plants of the Southern Pacific is looked to with interest. The book before us is a regular manual, and looking through its pages at once suggests a strange flora to one chiefly acquainted with north temperate regions. The structure of the islands, their topography, and the conditions of climate are described. All combine to favor a luxuriant vegetation, one more brilliant than varied, and chiefly remarkable for the number of individuals. The great display of evergreen and suffrutescent species is noted, followed by trees and shrubs, the annuals representing a very insignificant part of the vegetation. The largest families, in the order of their importance, are Ferns, Leguminosæ, Orchidaceæ, Rubiaceæ, Gramineæ, Cyperaceæ, Euphorbiaceæ, and Urticaceæ. The usually dominant family of Compositæ is feebly represented, but it is interesting from the woody and arborescent forms it contains. The author considers the Polynesian Compositæ to be American in their affinities. The species of French Polynesia can be thrown into three categories, (1) those that are peculiar to it, (2) those which it has in common with Oceanica exclusive of Malaysian flora, (3) those in common with the Indo-Malaysian region. The first group contains 28.9 per cent. of the flora, the second 20.8 per cent and the third more than the other two combined. The number of species described is 744, of which 144 are ferns.

[1] Del Castillo, E. Drake:—Flore de la Polynésie Française, description des plantes vasculaires qui croissent spontanément ou qui sont généralement cultivées aux îles de la Société, Marquises, Pomotou, Gambier et Wallis. 8vo. xxiv. 352, with colored maps. Paris. G. Masson. 1892.

Minor Notices.

PROFESSOR L. H. PAMMEL, in connection with an account of Sclerotinia libertiana, has published a very valuable bibliography of fungus root diseases, containing considerably over 500 titles. The paper appears in Trans. St. Louis Acad. 6: 191–232. 1893.

JUNCUS MARGINATUS and its varieties are discussed by Mr. F. V. Coville in a recent excerpt from Proceedings of the Washington Biological Society. The forms of this widely variable species have been variously treated. Mr. Coville separates the species into three forms, characterized as *J. marginatus* (type form), *J. marginatus aristulatus*, and *J. marginatus setosus*, the last of which has never happened to be characterized. Some useful suggestions are also made as to the treatment of such groups.

MR. WILLIAM E. MEEHAN'S "Contribution to the flora of Greenland" has been distributed as a reprint from the Proceedings of the Philadelphia Academy. As is well known, this reports the botanical results of the Peary expedition, the collections being made by Messrs. Burk and Meehan. Just 100 species of phanerogams and pteridophytes are enumerated. The profusion of lichens and mosses is remarked, thirty-nine species of the former, and twenty-eight of the latter being noted.

THE REPORTS of the State Botanist of New York for 1891 and 1892 are just at hand. The former contains a revision of the New York species of *Omphalia*, twenty-one in number, besides the descriptions of seventeen new fungi. The latter contains an account of the New York species of *Pleroteolus* and *Galera*, besides the descriptions of thirty-seven new fungi. It is stated that forty quarto plates of edible (59 species) and poisonous (3 species) mushrooms have been prepared, drawn full size, in color. These are ready for publication, together with suitable explanatory text. Their early appearance will delight all mycologists and mycophagists.

DR. WM. TRELEASE has been studying the winter condition of our maples, and also the confused sugar maples.[1] The treatment of the sugar maples has been so various that the synonymy is badly tangled. Dr. Trelease recognizes three species of the group SACCHARINA, namely, *A. saccharum* Marsh. (*A. saccharinum* of the Manual) with its varieties *barbatum* (*A. barbatum* Michx.) and *nigrum* (*A. saccharinum*, var. *nigrum* of the Manual); *A. Floridanum* Pax., with its variety *acu-*

[1] TRELEASE, WILLIAM:—Sugar maples, and maples in winter. Reprinted in advance from the 5th Ann. Rep. of the Mo. Bot. Gard. pp. 20 with 13 plates. January 1, 1894.

minatum; and *A. grandidentatum* Nutt. All these forms become varieties of *A. barbatum* in Sargent's Silva. This part of the contribution is illustrated by ten plates. The second part presents a winter synopsis of all North American maples, and with the help of three plates not only shows the possibility of determinations in the winter condition, but also develops new specific characters.

PROFESSOR S. C. MASON has published in the Eighth Biennial Report of the State Board of Agriculture a preliminary report upon the variety and distribution of Kansas trees.

DR. J. H. WAKKER opens a series of reports from the East Java Experiment Station[1] consisting of articles extracted from the archives of the Java Sugar-Industry, and treating of the diseases of sugar-cane and the improvement of cane by use of seed.

TWO PAPERS upon the flora of Wisconsin have been issued in the ninth volume of the Transactions of the Wisconsin Academy, and separates were distributed in advance of publication of the volume. These are "A preliminary paper on the flora of Dane county," by L. S. Cheney and R. H. True, and "A supplementary list of parasitic fungi of Wisconsin," by J. J. Davis. The first is prefaced by a brief account of the climatic and geologic conditions of the range covered and accompanied by a topographic map reproduced from the sheets of the U. S. G. S. It includes spermaphytes, pteridophytes and bryophytes. The second paper is supplementary to Trelease's list of the fungi of Wisconsin prepared in 1882.

THE SERIES of bulletins from the laboratories of natural history of the state University of Iowa has just now reached the close of the second volume. The current number contains ten papers, six of which are botanical. Mr. B. Shimek gives a full account of the botanical expedition to Nicaragua, which seems to have been very successful in the collection of material and notes; Professor McBride furnishes four numbers, namely, an account of the Nicaraguan Myxomycetes (which are strikingly like those of the northern United States, of the twenty-five species collected nineteen being identical with those commonly found in eastern Iowa, and the six new ones representing familiar genera), a continuation of the presentation of the myxomycetes of eastern Iowa (nine species, two of them being new), the description of a new Physarum from Colorado, and the description of a new fossil cycad (Bennettites) from the Jura-Trias of S. Dakota; and

[1] Mededeelingen Proefstation "Oost-Java." Nieuwe Serie. Roy. 8vo. Soerabaia 1893. No. 1, De bladziekten te malang, 7 pp. No. 2, Djamoer oepas op arrowroot en andere planten, 6 pp. No. 5, Onze zaadplanten van het jaar 1893, 13 pp.

Mr. Chas. L. Smith presents a synoptical view of Central American Pyrenomycetes, with descriptions of new species.

ANOTHER ONE of the "Contributions from the U. S. National Herbarium", being no. 8 of vol. I, has lately appeared, being of special interest as containing all the unpublished botanical manuscript of the late Dr. George Vasey, except that which had been prepared for the concluding part of his Monograph of the Grasses of the United States and British America. This material appears under the titles "Notes on some Pacific Coast Grasses" (in which 8 species are considered), "Descriptions of new or noteworthy grasses from the U. S." (in which over 30 new species are described, 17 of which belong to *Poa*), and "Descriptions of new grasses from Mexico" (16 in number). In addition to these numbers, Mr. J. M. Holzinger describes four new species from Texas and Colorado, and gives a list of 17 plants, new to Florida, collected by J. H. Simpson; Mr. J. N. Rose describes 3 new plants; and Mr. J. W. Eckfeldt gives a list of 42 lichens from California and Mexico, collected by Dr. Palmer from 1888 to 1892.

"BULLETIN of the Maine State College Laboratory of Natural History" is the descriptive title of another local publication to be issued at irregular intervals. The opposition of the GAZETTE to the multiplication of serials of an uncertain life tenure and limited distribution is well-known. The present instance appears less objectionable than usual, as the number before us (Vol. I, no. 2) contains only matter of local interest. It is dated January, 1893, although the number reached us only last month (Jan. 1894). It consists of two bare lists with localities, both prepared by F. L. Harvey and E. P. Briggs, one of the phanerogams and vascular cryptogams of the Blake Herbarium, "as it came to the college" (the only information descriptive of the collection), enumerating about 3,500 species, and the other of the phanerogams and vascular cryptogams of the state, principally from the vicinity of Orono, the college town, numbering less than a thousand species.

OPEN LETTERS.

Acknowledgment.

In my article in this journal, 18: 455, entitled *Studies in the biology of the Uredineæ*, I have described an unusual method of formation of sporidiola, and stated that so far as I knew, it had been unobserved before. I have since discovered (soon after my article was in print) that Dr. Farlow refers briefly to this phenomenon in *Gymnosporangia of the United States* 9, and there cites Cramer also, who mentions the same process in *Ueber den Gittterrost der Birnbäume und seine Bekämpfung*, in Schweizer landw. Zeitschrift 1876. 7, as occurring in the germination of *Gymnosporangium*. Moreover, Dr. Farlow mentions the *germination* of these sporidiola, which I have not *certainly* observed, although, in one culture, one individual seemed to be germinating. He also tells me that Dr. Thaxter mentions the same process in his paper *On certain cultures of Gymnosporangia*, in Proc. Acad. Arts and Sci. 1886, 260, which paper I have not yet seen. I have carried on rather extensive cultures of *Gymnosporangium* (with two species, *G. macropus* and *G. globosum*), but have never yet observed such phenomena in that genus. I have already mentioned, in footnote ten of my article (l. c.), Lagerheim's observations with LEPTOPUCCINEÆ, but further experiments are necessary to establish the identity of the phenomena observed by him with the process I have described. There is a very marked error in this reference. The words "in which I do not find this process" should read "which is not true of my observations."—M. A. CARLETON, *Kansas Experiment Station, Manhattan.*

NOTES AND NEWS.

MR. R. BENTLEY, emeritus professor of botany in King's College, London, died December 24, 1893.

MR. JOHN DONNELL SMITH sailed February 10th for another visit to Central America, whose flora he is so energetically investigating.

DR. RICHARD SPRUCE, the well-known English traveler, collector and hepaticologist, died at his home at Coneysthorpe on the 28th of December, at the age of seventy-six.

MR. G. H. HICKS, instructor in botany in the Michigan Agricultural College, has been appointed assistant botanist in the Division of Botany of the Department of Agriculture.

MR. ALBERT F. WOODS, assistant in botany in the University of Nebraska, has been appointed assistant pathologist in the Division of Vegetable Pathology of the U. S. Department of Agriculture.

IN THE ABSENCE of Prof. V. M. Spalding from the University of Michigan for a year's study in Germany, Mr. F. C. Newcombe, who returned from Europe last summer, has been placed in charge of the instruction in botany.

DR. E. BONAVIA has been trying to identify the plants of the Assyrian monuments. In some cases the identification seems to be sure enough; in others the representations are so conventional as to give rise to large diversity of opinion.

NOTICE has been received of the death of Rev. Samuel Lockwood, Ph. D., of Freehold, N. J., which occurred January 13th. Professor Lockwood was an ardent naturalist and a very ready writer. He was one of the first subscribers to the GAZETTE, and made several contributions to its earlier volumes.

OF THE ANNUAL REPORTS of experiment stations for 1892 two are especially interesting for their botanical matter: Vermont and New Jersey. The former contains fifty-five pages on plant diseases, by L. R. Jones, and the latter 112 pages on plant diseases and weeds, by B. D. Halsted. Both reports are well illustrated.

HEDWIGIA appears in an enlarged and somewhat altered form. Each bi-monthly part is to consist of 64–80 pages, with 2–3 plates. The original articles are to be paged separately from the abstracts of cryptogamic literature, and will occupy from 16–32 pages. The price is increased from eight to twelve marks.

IT SEEMS that the "Russian thistle" (*Salsola Kali* var. *Tragus*), which has proved so destructive in South Dakota is threatening to spread over Nebraska. Bulletin 31, of the Agric. Exp. Station of Nebraska, prepared by Dr. Bessey, deals with the subject, giving an account of the structure of the plant and suggestions as to co-operation for its eradication.

In the Linnean Society's Journal (30: 51), the first paper by Mr. J. C. Willis, under the title, "Contributions to the Natural History of the Flower" appears. It discusses the fertilization of *Claytonia* (two species), *Phacelia* (five species), and *Monarda* (three species), and is illustrated by one plate. It seems that the writer is presently to visit the western United States, where some of the species of the paper and others can be studied in their native haunts.

The prize of 500 francs, founded by Augustin-Pyramus de Candolle will be awarded by the Société de physique et d'histoire naturelle de Genève for the best unpublished monograph of a genus or family of plants submitted through the president, M. Ch. Soret, before January 15, 1895. The manuscripts may be written in Latin, French, German (Roman letters), English or Italian, and the society will publish the accepted one in its quarto memoirs if agreeable to the author.

Iowa Agricultural College has recently purchased the Parry Herbarium and Library for the sum of $5,000, which it hopes to make of service to the working botanists of this country. This collection was brought together by Dr. C. C. Parry, who died in 1890. It is especially rich in West-American plants. The specimens are in excellent condition and with the 25,000 specimens now in the college collection there is an abundance of material for a large herbarium.

On the eighth of December, 1893, Professor Dr. Jacob George Agardh celebrated in Lund, Sweden, his eightieth birthday. On this occasion Prof. Dr. J. B. De Toni, on behalf of a large number of phycologists, presented to the distinguished Swedish algologist, an artistically gotten up address with the signatures of all those taking part therein. The simple text of the address runs: "Clarissimo phycologo —J. G. Agardh—ineunte aetatis suae anno octuagesimo—(8. Dec. MDCCCXIII—MDCCCXCIII)—gratulantes offerunt aestimatores." —Bot. Centralb. 57: 96. 1894.

Mr. A. D. Hopkins, entomologist of the West Virginia Agricultural Experiment station, has ready for printing the manuscript and illustrations for a popular bulletin on "Defects in wood caused by insects," and "Black holes in wood." The bulletin will contain over forty figures from original drawings and photographs from nature, with accounts of the characters of the defects and the insects causing them; simple and inexpensive methods of preventing the occurrence of certain kinds, together with other matter intended to be of interest to the general reader. It will be sent free to those requesting it.

In the *Bulletin of the Torrey Botanical Club* (Dec.) Mr. John K. Small gives an account of the altitudinal distribution of the ferns of the Appalachian mountain system, representing a kind of work in geographical distribution that deserves much careful attention. In addition to the stations, with their elevations, each species, following the lines of Allen's Geographical Distribution of N. Am. Mammals, is referred to one of four faunal areas, viz.: Canadian, Alleghanian, Carolinian, and Louisianian. In the same number Dr. Thomas Morong gives some interesting results of his studies among monocotyledons.

Dropsical diseases of plants constitute a new class of maladies brought to light within a year by Prof. Geo. F. Atkinson, of Cornell University. He writes in *Science* (Dec. 15, 1893), of tomatoes and apples thus affected; and in *Garden and Forest* of a later date (Dec. 27, 1893), adds an account of violets grown in forcing houses, which suffered severely in a like manner. In the last case the small veinlets on the under side of the leaf show little swellings, which finally dry up, the leaf gradually turns yellow and dies. An instance is cited where all the plants of a large establishment lost their leaves from this cause, and became worthless.

The Botanical Seminar of the University of Nebraska has undertaken the publication of a "Flora of Nebraska," in which the entire flora of the state is to be described. The work will appear in twenty-five parts, not more than three or four in any one year, and will cost one dollar a part. Illustrations are to be freely used to illustrate the lower groups and the more difficult phanerogams. While the prospectus is apparently addressed to students of botany in Nebraska it is of decided general interest, as it not only represents an effort unique in this country, but deals with one of those "middle regions" that have never had fair treatment at the hands of manuals.

In the *Journal of Botany* (Jan.) Mr. F. N. Williams discusses the primary subdivisions in the genus *Silene*. He points out the "inconvenience of regarding the mode of præfloration in the petals as a primary character." The primary divisions he bases on the structure of the calyx, slightly modifying Rohrback's arrangement, and follows Engler and Prantl in regarding each division as a subgenus, of which three are recognized. The delimitation of the genus by the character of a unilocular capsule septate at the base transfers many of the North American species to the genus *Melandryum*.

In the Proceedings of the Cambridge (England) Philosophical Society (8: part 2), Messrs. J. C. Willis and I. H. Burkill give the results of observations on the flora of the pollard willows near Cambridge. The willows were polled at a height of eight feet, and stood in rows a few yards apart. Their tops contain large masses of humus, in which occur many plants. No less than eighty species have been found growing in this situation. In abundance of occurrence *Galium Aparine* heads the list, followed by *Sambucus* and *Rosa*. *Urtica* and *Cratægus* are also common. Questions as to the mechanism of seed distribution are suggested. The fact that birds' nests are common in willow tops led to an investigation also of the plants used in building.

At the eighth annual session of the Iowa Academy of Sciences, the following botanical papers were read: T. H. McBride: Notes on the North American Cycads, and The distribution of *Rhus typhina*; S. Calvin: On the geological position of *Bennettites dacotensis* MacBride, with observations on the stratigraphy of the region in which the species was discovered; A. C. Spencer: A Mazon flora in Iowa; Mary A. Nichols: Observations on the pollination of some of the *Compositæ*; B. Fink: Some additions to the flora of Iowa; L. H. Pammel: Powdery mildew of the apple, Farther notes on *Cladosporium carpoph-*

ilum Thüm., and Notes from the botanical laboratory of Iowa Agricultural College. The presidential address was also given by Prof. Pammel, the subject being: Bacteria; their relation to modern medicine, the arts and industries.

The editorial plea for more attention to physiological research in the state agricultural experiment stations, given in a recent number of *Experiment Station Record* (5 : 270–271), is to be heartily commended. A few sentences may be quoted here: "The systematic investigation of the physiology of particular species of plants throughout their life history is greatly needed. The practical, as well as the scientific, importance of such researches in the case of cultivated plants is very great. It is true that physiological inquiries, whether on plants or animals are difficult to carry on. However these things which are hard to find out are the very ones our institutions for experimental research should seek after. Wherever opportunity offers laboratories should be equipped and trained workers employed for investigations on the physiology of cultivated plants."

In the *American Naturalist* (Jan.) Dr. Chas. E. Bessey presents a synopsis of the larger groups of the vegetable kingdom. This synopsis, in chart form, had already been distributed and welcomed in our laboratories. The slime moulds have been excluded, as more properly belonging to the animal kingdom. The "classes" are those usually recognized, but in the first two the limits have been slightly extended. The groups below classes are tentatively called "orders," and as the orders of the lower plants are found to be equivalent to the "series" of Bentham and Hooker, the former term is made to supplant the latter, and the so-called "orders" of the manuals become simply "families." Of course the group of "Apetalæ" is not kept separate, and apocarpous and hypogynous characters are regarded as primitive and lower than the syncarpous and epigynous condition. The six "branches" are Protophyta (fission algæ, including bacteria), Phycophyta (green and brown algæ), Carpophyta (the old "spore-fruit" group), Bryophyta, Pteridophyta, and Anthophyta.

The radiation and absorption of heat by leaves has been studied by A. G. Mayer (Am. Jour. Science 45 : 340–346. 1893). He found that the leaves of ash, elm, maple, cherry, horse chestnut, lilac, mullein, burdock and chicory absorb from 77 to 86 per cent. of heat falling upon them, and transmit from 14 to 23 per cent. The radiation is the same as the absorption. Variations are largely due to individual differences of the leaves of the same species, there being little difference between species of even widely separated genera, or between species with very different texture of leaves. Thus, the leaves of maple and mullein are essentially alike in their relation to heat. The petals of rose and other flowers transmit much more heat, and retain less, than leaves. The upper and lower surface of leaves were not found to differ in their behavior toward heat, with the single exception of burdock, which radiates but four-fifths as much from the lower as from the upper surface. Leaves are among the best absorbers and radiators of heat known. A coating of dew over the surface, however, will reduce the radiation by one-third.

AT A RECENT meeting of the botanical section of the Schlesische Gesellschaft für Vaterländische Cultur, Dr. Ferdinand Cohn spoke on formic aldehyde and its effect on bacteria. Among other interesting matters he called attention to Hauser's method of permanently fixing gelatin tube and plate cultures of bacteria by vapor of formic aldehyde, obtained by pouring a few drops of the solution on cotton. Microscope preparations may be then made by cutting out little pieces from such plate cultures. The permanence of these fixed cultures depends on the formation on contact with the vapor of a solid and hard modification of gelatin, which is not fluid at any temperature. Gelatin liquefied by bacteria is also rendered solid, while retaining the optical appearance of its fluid condition.

Cohn also found that very dilute watery solutions of formic aldehyde preserve plant tissues and organs, as well as the delicate algæ perfectly. The blackening often occasioned by alcohol is not produced, and the green color is completely preserved. The permanence of these materials can only be known after longer tests than the six months which these have continued. The addition of 15–20^{ccm} of the commercial 40 per cent. solution to a liter of water makes a solution of preservative strength. In working with formic aldehyde care must be exercised, as its vapor produces severe headache and irritates the mucous membranes.

THE Geological and Natural History Survey of Minnesota is organized upon a very liberal basis, especially favoring exploration and publication. The Bulletins, issued from time to time, have contained much valuable material. The state botanist, Professor Conway MacMillan, now proposes to publish Bulletin no. 9 in parts, under the title, "Minnesota Botanical Studies," until a volume is completed. The first part (Jan. 16, 1894), contains the following papers: "On the occurrence of sphagnum atolls in Central Minnesota," by Conway MacMillan, in which the structure and origin of these peculiar annular structures are discussed; "Some extensions of plant ranges," by E. P. Sheldon, in which a new Polygonum and a new Aster are described; "On the nomenclature of some N. Am. species of Astragalus," by E. P. Sheldon, in which the recent American rules of nomenclature are applied and two new species described; "List of fresh-water algæ collected in Minnesota during 1893," by Josephine E. Tilden, including eighty-nine numbers; "On the poisonous influence of Cypripedium spectabile and C. pubescens," by D. T. MacDougal, in which the poisonous effects of the former are reported to have been demonstrated, and inferred for the latter. A peculiar pointed hair and a glandular hair are looked to as possible causes of the irritation. Three plates illustrate the new Polygonum, the new Aster, and the hairs of Cypripedium.

IN THE *Kew Bulletin* for October and November (1893), some account is given of the botanical exploration of Sikkim-Tibet frontier (Bengal province of N. India). A long report is given by G. A. Gammie of a botanical tour in Sikkim in 1892, accompanied by a note from Sir Joseph Hooker, which comments in such an interesting way upon the general botanical features of the region that we quote as follows:

"Mr. Gammie's report strengthens in me the opinion which I have long entertained, but which I have never formulated, that Sikkim, for its area, presents one of the richest, if not the richest, botanical regions of the globe. And further, that though no more than about forty miles from east to west, and 100 from north to south, and situated beyond the northern tropic, I believe that, when all that is known of its vegetation shall have been brought together, it will prove to be a better microcosm of the flora of the globe than any other area of equal or even much larger dimensions.

Thus, in its alpine region, the floras of the European, Siberian, Chinese, and American mountains are all richly represented, and there also are found the principal types of the steppe and desert vegetations of Tibet and Central Asia. In its temperate region European genera abound in species in greater numbers than they do further west in the Himalaya, or probably than they do further east in the same range, where different climatic features prevail; and in the same region types of Chinese, Japanese, and North American (both eastern and western) genera appear in force, and which rapidly disappear in advancing toward the Western Himalaya. Lastly, in the tropical region, the Malayan flora disputes precedence with those of the plains and lower hills of the Indian continent, Burma and Ceylon, as represented by genera and species, many of which are also characteristic of tropical Africa. In short, with the exception of the prevalent types of the Australian, South African, and South American floras, there are few others that do not meet the eye of the wanderer in Sikkim."

DR. D. H. CAMPBELL is continuing his studies of the general relationships of the pteridophytes, and is each year furnishing more and more material upon which to base a natural classification. The latest subject of his investigation has been the development of *Azolla filculoides* Lam. It seems that it is this species rather than the eastern A. Caroliniana, that is found in California. With abundance of living material accessible, the author has made a complete study of the development of Azolla, concerning which litttle is known. The anatomy of the mature sporophyte had been thoroughly presented by Strasburger, but the account of the development of the prothallia and embryo was still incomplete.

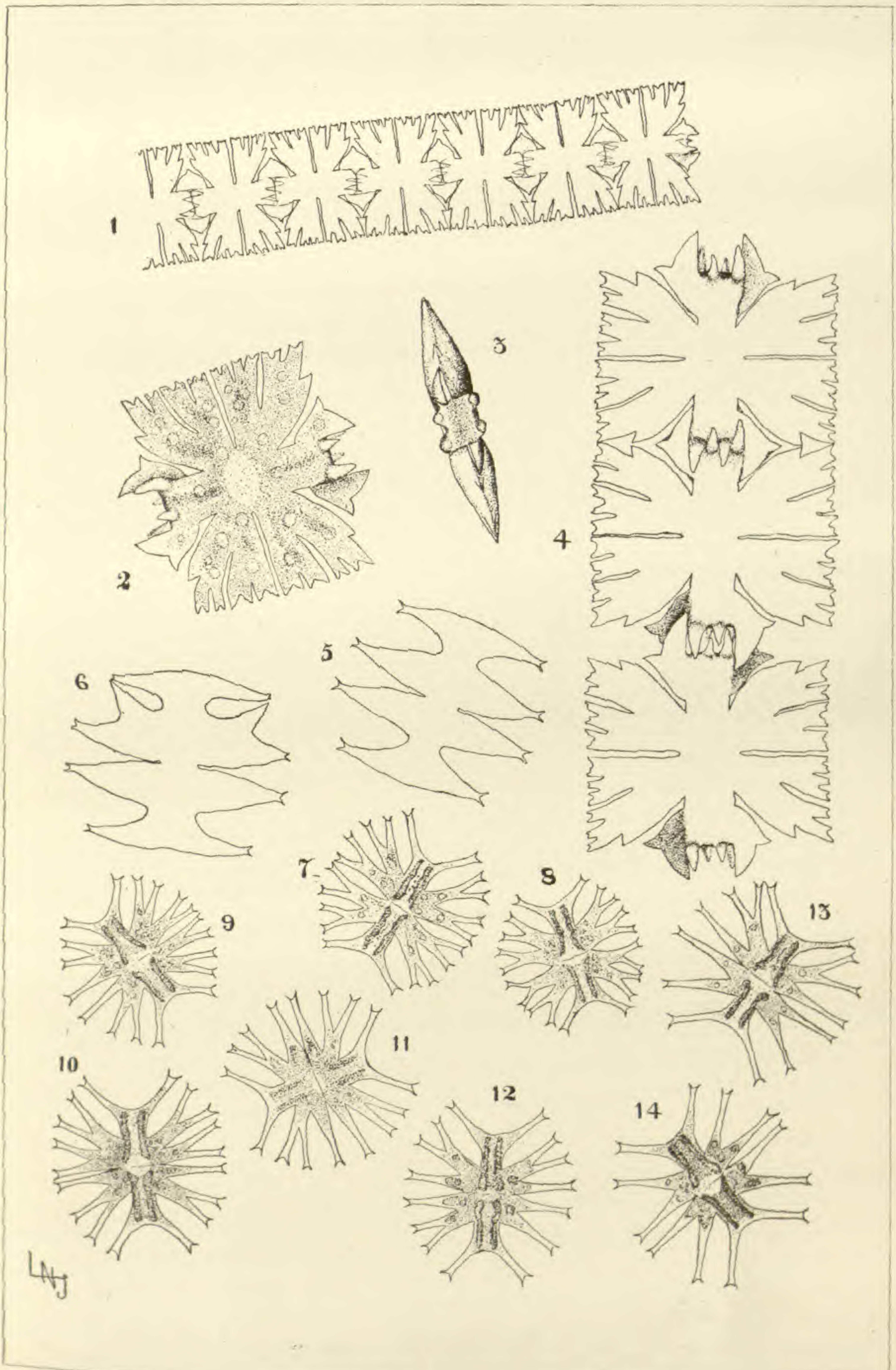
After giving a brief account of the structure of the mature sporophyte, the author describes the development of the macrosporangia, the germination of the microspores, the germination of the macrospores, the development of the archegonia, of embryo, of the cotyledon, of the stem-quadrant, of the root, and of the foot. In every case resemblance to no other form is indicated by the development of Azolla, and the genus seems an isolated one, with Salvinia as its nearest living ally.

The general conclusions as to relationships are summed up as follows: "That the two families of the Hydropterideæ represent the ends of two different lines of development. Of these the Salviniaceæ have been derived from the lower members of the leptosporangiate series, possibly from near the Hymenophyllaceæ, and that the Marsiliaceæ have arisen from forms more like the Polypodiaceæ. Of the two families, the Salviniaceæ have departed less from the parent stock in regard to the reduction of the sexual generation, but the sporophyte is much less like that of the ordinary homosporous forms than that of the Marsiliaceæ.

The two genera of Salviniaceæ differ much more from each other than do those of the Marsiliaceæ, and it is not at all likely that one form has been derived from the other but that the two genera diverge at an early stage in the development of the line."

Recent experiment station bulletins include excellent data on methods and profit of spraying orchards, and on some new fungicides, by E. G. Lodeman (Cornell, N. Y., no. 60); on effect of fungicides upon germination of corn, with bibliography, by A. S. Hitchcock and M. A. Carleton (Kans., no. 41); on club root of cabbage and its allies, by B. D. Halsted (N. J., no. 98); on the tomato and some of its diseases, by P. H. Rolfs (Fla., no. 21); on common fungous diseases and methods of prevention, also on dodder, by C. V. Piper (Wash., no. 8); on the Russian thistle in Nebraska, by C. E. Bessey (Neb., no. 31); on the Russian thistle in Wisconsin, by E. S. Goff (Wisconsin, no. 27); and on winter-killing of trees and shrubs, by Aven Nelson (Wyoming, no. 15). The last is directed toward the causes of desiccation in winter and at high altitudes. Experiment showed that lowering the atmospheric pressure produced increased loss of moisture from an Ilex plant. Nevada weeds is a subject that is treated by F. H. Hillman (Nev., no. 21) in a manner that is almost model. A novel feature is introduced by attaching a fragment of the plant with a few seeds to the page to accompany the description. Eight of the most common weeds are described, half being illustrated with admirable half-tone cuts in addition to the dried specimens. A bulletin on fruit blight in general, by J. M. Stedman (Ala., no. 50), is a good example of pseudo-science, not half of the statements being true, and the experimental part being entirely unreliable. Electro-culture is again taken up by C. D. Warner (Hatch, Mass., no. 23), and although the experiments are apparently elaborate, they are almost wholly empirical, and grossly lacking in scientific detail. No attempt seems to have been made to determine the amount of current passing through the soil, but as near as one can judge from the data given, it was not half the total efficiency. Of course the amount of current passing exclusively through the wire is immaterial, unless magnetic effects are to be assumed, which is highly improbable. The author does not tell us whether a stimulation of the physiological action of the plant or electrolysis of the constituents of the soil is to be expected. The former is scarcely probable and the latter is out of the question with an alternating current. More profound experiments are needed to secure data of much value.

THAXTER on NAEGELIA, Reinsch.



JOHNSON on MICRASTERIAS.

BLODGETT on ERYTHRONIUM.

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THE

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In the April number will appear:

On the absorption of water by the green parts of plants, by W. F. GANONG, *Harvard University.*

The influence of mechanical resistance on the development and life period of cells, by F. C. NEWCOMBE, *University of Michigan.*

Artificial cultures of an entomogenous fungus, by PROF. GEO. F. ATKINSON, *Cornell University.*

The Ware collection of Blaschka glass models at Harvard, by WALTER DEANE, *Cambridge, Mass.*

BOTANICAL GAZETTE

MARCH, 1894.

Some rare Myxomycetes of central New York, with notes on the germination of Enteridium Rozeanum.

ELIAS J. DURAND.

Plate XII will be issued with the next number.

which will be noted in this paper.

I. Rare Myxomycetes.

ARCYRIA MACROSPORA Peck, 34th Rep. of the N. Y. State Mus. Nat. Hist., 1881, p. 43.—This species illustrates the fact, that the characters of species of Myxomycetes depend largely upon the power of the objective used in their study. Markings which appear to be of a certain character, when viewed with a one-fifth inch objective, are found to be entirely different when examined with a one-twelfth inch oil immersion objective. For example, the spores of *Trichia fallax* have long been described as warted, but under the one-twelfth inch objective, the epispore is found to be delicately reticulated. Dr. Peck evidently based his description of *Arcyria macrospora* upon observations made with the lower

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Some rare Myxomycetes of central New York, with notes on the germination of Enteridium Rozeanum.

ELIAS J. DURAND.

WITH PLATES IX AND X.

The lake region of New York state is famous as a botanical collecting ground. In the Cayuga region alone 1,278 species of phanerogams have been catalogued. Although flowering plants are so abundant, ferns, mosses, algæ and fungi occur in great profusion. The Myxomycetes form no exception to this rule. The multitude of gorges and ravines, which render the region of Ithaca picturesque and unique among our lake valleys, presents an environment very favorable to the development of these singular organisms.

A large number of Myxomycetes have been collected near Ithaca at various times, but especially during the last two years. Many interesting species have been found, several of which will be noted in this paper.

I. Rare Myxomycetes.

ARCYRIA MACROSPORA Peck, 34th Rep. of the N. Y. State Mus. Nat. Hist., 1881, p. 43.—This species illustrates the fact, that the characters of species of Myxomycetes depend largely upon the power of the objective used in their study. Markings which appear to be of a certain character, when viewed with a one-fifth inch objective, are found to be entirely different when examined with a one-twelfth inch oil immersion objective. For example, the spores of *Trichia fallax* have long been described as warted, but under the one-twelfth inch objective, the epispore is found to be delicately reticulated. Dr. Peck evidently based his description of *Arcyria macrospora* upon observations made with the lower powers of the microscope. Under the highest powers, the characters appear to be so different as to be scarcely recognizable. I, therefore, redescribe the species on this basis.

The description is drawn from material in the Cornell University Herbarium, collected at Ithaca in 1879, and sent to Dr. Peck, in 1880, for determination. It is labeled "*Arcyria macrospora* Peck, n. sp.," and is referred to by him in his description (l. c.).

Plants crowded or gregarious, stipitate, collected on a common hypothallus. Sporangia globose, or shortly elliptical, deep brick-red in color, with a shade of brown. Dehiscence circumscissile. Hypothallus yellowish-brown, shining, forming a broad thin sheet, on which the sporangia stand. The stipe equals the sporangium in length, and is dark brown, almost black in color. The base of the sporangium after dehiscence forms a shallow cup, in the center of which the capillitium is loosely attached, much as in *A. adnata*. The capillitium is dense, with the spore-mass deep brick-red in color when fresh, fading to cinnamon brown with age. The capillitial threads are about 6μ in diameter, and are quite closely combined into a net. The markings consist of broad raised bands, closely combined in a reticulate manner. The bands are so thick that they appear as coarse warts when seen in cross section along the edge of the thread. The spores are minutely verrucose, and very large, being $10–13\mu$ in diameter. Plate IX, figs. 1, 3; plate X, fig. 9.

This is a very distinct species, being strikingly different from all of our other species of *Arcyria*. Externally the appearance is much like that presented by specimens of *A. adnata*, but the internal characters of the species are recognizable at a glance. The large size and peculiar markings of the capillitial threads, together with the large warted spores, are peculiarities which cannot be overlooked.

The description is much the same as that of *A. inermis* Racib. Myx. Cracov., 1885, as given in Massee's Monograph. If the species be identical, Peck's name has the priority by four years.

This species seems as yet to be quite rare. The only localities known at present are: Copake, Columbia Co.; Grafton, Rensselaer Co., and Ithaca, Tompkins Co.; all in New York. The Copake and Grafton localities are given on the authority of Dr. C. H. Peck.

The plant was noticed at Ithaca first in 1879, when it was collected from a hemlock log, in Fall creek ravine. On April 13, 1893, I collected specimens from the same station. In June, 1893, a few specimens were found in Cascadilla ravine also, on a hemlock stump. I suspect that the species has been overlooked on account of its external resemblance to *A. punicea* and *A. adnata*.

CRIBRARIA PURPUREA Schrader, Nov. Pl. Gen., p. 8, 1797.—Plants usually scattered. The hypothallus is small but distinct, formed only of the thick, expanded foot of the stipe. Stem rather elongated, usually two or three times as long as the diameter of the sporangium, dark purple. Sporangium large, globose, reddish purple. The calyculus occupies rather less than one-half of the sporangium, and is usually ribbed. The thickened portions of the sporangium form an irregular net-work. The nodes are irregular in form, but are somewhat elongated, and filled with purple granules. The connecting threads are nearly colorless, with numerous free branches, in the form of short projections, or of threads which are not connected with any node. The spores are purple in mass, but colorless by transmitted light. They are 5–6.5μ in diameter, smooth.

This is a fine species, very distinct from *C. elegans* B. & C., with which it is perhaps confused. It is the largest and by far the most beautiful species of the whole genus. It usually covers considerable areas on the log where it occurs. When the spores are dispersed they lodge on the mosses and rotten wood, when the deep purple color is very conspicuous, so that it may be seen from a considerable distance.

The species is by no means common, and is usually found in cool or mountainous regions. Dr. Peck writes me that he has found it in the Adirondack and Catskill mountains, and at Sand Lake, New York. He has received it from Canada, (*Macoun*) and from Maine (*Harvey*). At Ithaca three stations are known: Six-mile creek, Fall creek, and Coy glen. At these places the plants grow on logs, the individuals standing indifferently on mosses or the rotten wood. Plate IX, figs. 2, 4, 5.

TRICHIA ERECTA Rex, Proc. Phil. Acad. Sci., 1890, p. 193.—A small quantity of this rare myxomycete was collected from a rotten log, in Coy glen, near Ithaca, April 15, 1893. The specimens correspond very well to the description by Dr. Rex, and are almost exactly similar to the material distributed as no. 2,496 of the North American Fungi.

Dr. Rex has given an excellent account of the species in the proceedings cited above. The only station known at that time was in the Adirondack mountains. Whether additional ones have been discovered since, I am not able to state. This is a fine species, distinguished among the Trichias by the stipitate checkered sporangia, the spinulose cylindrical elaters, and the warted spores.

II. Germination of Enteridium Rozeanum.

Enteridium Rozeanum (Rost.) Wing.—It is my purpose in this part to present some of the results of studies upon the swarm-cells of Enteridium Rozeanum. These investigations were undertaken during the winter of 1893, as a part of some special work upon the group of organisms to which this plant belongs. The material from which the cultures were made was collected from an old log on Fall creek flats, an extensive swamp at the head of Cayuga Lake. The plants were found about the middle of October, 1892, and put away in a dry place. In December, the germination of the spores of a large number of species collected during the fall was tried, but those of Enteridium were the only ones which showed any signs of germination. I considered myself fortunate to have succeeded even so much, for the difficulties in the way of germinating the spores of Myxomycetes are well known.

As is the case with many fungi, myxomycete spores require a period of rest before germination will take place. The length of this period seems to vary, not only according to the species, but also according to the conditions under which the spores are kept. Fully as important a consideration is the medium in which the germination is attempted.

The method of culture which I employed was the well-known moist chamber formed from several thicknesses of filter paper, wet with distilled water, sustaining a cover-glass, upon which, in a hanging drop of water, the spores were sown. The best temperature for germination seems to be about 70° F.

When about to germinate, the spore absorbs water, the protoplasm swells, rupturing the wall of the spore along one side. Through the V-shaped opening thus made the nucleated protoplasm flows or streams out in a mass (plate IX, figs. 6, 7, 8). After leaving the spore the protoplasm, or, at it is now called, the swarm-cell, becomes spherical, and undergoes a short period of rest (plate X, fig. 10). The swarm-cells at this time measure about 9μ in diameter. This diameter is found to be, on an average, about one and one-half times that of the original spore.

After remaining in the spherical resting state for a short but variable time, the swarm-cell assumes a new form. The body elongates, becoming cylindrical or fusiform, measuring about $12\mu \times 2-3\mu$. At one end a cilium is produced which is long and lash-like, three to five times as long as the long diameter of the cell body. Often two cilia are produced,—*one at each end* (plate X, fig. 12). This biciliate condition seems to be peculiar to Enteridium Rozeanum, so far as I have been able to ascertain. De Bary mentions the fact that two cilia are occasionally produced, but his figures represent both cilia at the same end.

By the lashing of the cilium the swarm-cell is made to move rapidly through the water, executing what De Bary calls the "hopping movement." I cannot see the appropriateness of this term. It appeals to me more as an oscillatory or undulatory motion. Through the rapid lashing of the cilium, the body oscillates as if hung on a pivot at the center. The cell meanwhile is in constant amoeboid movement, so that its form is constantly changing, to a limited extent. The form of the body does not change as a result of the motion of the cilium, but by virtue of some force within the body of the cell itself. The vibration seems to be in a horizontal plane, and not the double conical or figure-of-eight movement possessed by many bacteria. In the case of the biciliate swarm-cells, the kind of movement does not differ materially from that of those with one cilium. The oscillatory movement is the same, but its rapidity is much increased. In many cases it is almost impossible to follow a vigorous cell in its vibrations, so rapidly does it move.

The general shape of the uniciliate swarm-cell is fusiform, the cilium being at the smaller, pointed end. In almost every instance, the uniciliate swarm-cells of Enteridium Rozeanum possess a curious appendage at the larger, posterior end (plate X, fig. 11). This consists of a spherical mass of protoplasm, with a diameter slightly less than the short diameter of the cell body. This appendage contains a vacuole, and is joined to the cell body by a short thread of protoplasm. In no instance have I observed this separating from the cell body. I did not once observe the creeping movement of the swarm-cell described by De Bary and Lister. When this movement is begun, the oscillatory movement is said to cease, while the cell moves slowly along the glass, with the cilium directed forward.

In the course of its amoeboid movement the cell assumes many forms. Sometimes it is nearly straight. Again it will be bent double, so that the anterior and posterior ends are nearly in contact. At other times protrusions or pseudopodia appear in parts of the cell, so that the body assumes almost numberless outlines.

The swarm-cells, after remaining two or three days in the ciliated state, absorb their cilia and pass into an amoeboid stage, when they are nearly spherical in form. Amoeboid movement takes place constantly, although but slowly and to a slight degree (plate X, figs. 13, 14, 15). It is at this time that division takes place. This process I now outline as observed in the case of a single swarm-cell. When first noticed the cell appeared a little longer than broad. While under observation, it lengthened slightly, and a constriction appeared on each side in the middle of its length. This constriction gradually deepened, as if a cord, tied around the cell, were being drawn so as to cut it in two. As the process continued the constriction became deeper and deeper on each side, until finally the two parts were held together by only a narrow thread of protoplasm. In time, this also disappeared, and the two parts became distinct and separated from each other. Each was then spherical in form. The time occupied in this division was about thirty seconds.

After undergoing division for a time, the spherical swarm-cells collected into small groups or colonies. In these cells which are closely packed together, the thin layer of ectoplasm occupying a little less than one-fourth of the radius, appears clear and transparent. Within, the granular endoplasm contains the nucleus and vacuoles (plate X, fig. 16). This differentiation of the protoplasm is not apparent in the swarm-cells under other conditions. The cells retain their individuality for a time, but are soon seen to be blending together into a common mass, the young plasmodium (plate X, fig. 17).

The plasmodia are about 24μ in diameter, whereas the spherical swarm-cells are only about 9μ. Whether the nuclei of the cells remain distinct in the young plasmodium, I was not able to determine. But in the plasmodium there is only one contractile vacuole, while each of the component cells contained one. The movements of the mass are distinctly amoeboid, and the protoplasmic currents can be clearly seen in the plasmodium as it moves slowly from place to place. The expansion of the contractile vacuole is very gradual until it attains its full size. After remaining expanded for a moment it suddenly disappears entirely. The time occupied from one disappearance to another is from forty to sixty seconds.

In the movement of the young plasmodium the protoplasm flows in a definite direction for a time, until a large pseudopod is formed. The rest of the plasmodium then flows into the pseudo pod. The movement is that of the whole mass in a definite direction. The young plasmodium meanwhile is irregular in outline, owing to the putting out of small pseudopods from all sides of the mass.

I was unable to induce the development of this species beyond the young plasmodial stage. Many different methods of culture were tried, with many different media, but all without success. I was particularly desirous of obtaining a mature plasmodium of this species, in order to study the formation of the æthalium. As is well known, the arrangement of sporangia in the æthalium is very complicated, and the mode of their formation and union is at present unknown. Perhaps some one, more fortunate than myself, may be able to complete these observations, and work out this interesting structure.

My acknowledgments are due to Prof. G. F. Atkinson for suggestions and kindly advice in carrying out this study.

Botanical Laboratory, Cornell University.

EXPLANATION OF PLATES IX AND X.—The scale where known is indicated with each figure. Figures 6–8, and 10–17 are drawn without reference to a scale; in these figures the unbroken lines surrounding the protoplasm are to be understood as indicating boundaries only, and in no case cell walls.

Fig. 1. sporangium of *Arcyria macrospora*.—Fig. 2, spore of *Cribraria purpurea*.—Fig. 3, spore of *Arcyria macrospora*.—Fig. 4, sporangium of *Cribraria purpurea*.—Fig. 5, portion of sporangial wall of same.—Figs. 6–8, germinating spores of *Enteridium Rozeanum*.—Fig. 9, portion of capillitium of *Arcyria macrospora*.—Fig. 10, spherical swarm-cell of *Enteridium*.—Fig. 11, ciliated swarm-cell with appendage.—Fig. 12, biciliated swarm-cell.—Figs. 13–15, amœboid swarm-cells.—Fig. 16, coalescing swarm-cells.—Fig. 17, young plasmodium.

Contributions from the Cryptogamic Laboratory of Harvard University. XXIII.[1]

Notes on the life history of a blue-green motile cell.

BRADLEY MOORE DAVIS.

WITH PLATE XI.

In view of certain opinions that have been expressed by some botanists, notably Hansgirg, but which most botanists have not generally accepted, that there exist motile conditions of certain members of the MYXOPHYCEÆ (CYANOPHYCEÆ), the writer was much pleased when last November he happened to meet with a unicellular blue-green motile organism and was able to trace its life history.

These blue-green motile cells were first noticed while examining some material collected from a pool in the salt marshes of the Charles river, Cambridge. They appeared in such quantities in vessels holding the collections of *Beggiatoa*, *Oscillatoria*, *Melosira*, *Cladophora*, *Enteromorpha clathrata*, etc., found in the salt marshes, that they formed a scum upon the surface of the water and sides of the vessels, where they readily passed into a non-motile stage. The source of the blue-green swarmers was soon traced to colonies of bluish-green cells, that resembled colonies of Polycystis, and were found commonly adhering on the sides of marsh grass (Spartina) and other objects. The measurements of these cells were identical with those of *Polycystis pallida*, and the colonies resembled strikingly the herbarium specimens of this species.

Anton Hansgirg has been the most prominent champion of polymorphism among the Myxophyceæ. He has expressed himself as believing that species of Euglena[2] give rise to Oscillatoria filaments and certain blue-green swarmers he thinks may come from Oscillatoria filaments[3] although he has not seen their formation. Goebel[4] states that he has seen the formation of swarm spores in Merismopedia. Thus it was

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[1] Prepared under the direction of Dr. W. G. Farlow.

[2] Hansgirg, Botanisches Centralblatt **23:** 232. 1885.

[3] Hansgirg, ibid. p. 230.

[4] Goebel, Outlines of Class. and Sp. Morph. of Plants (Engl. trans.) 22. 1887.

with considerable interest that the writer undertook the study of the form which he had found whose non-motile state so closely resembled *Polycystis pallida.*

Motile stage.

The motile cells were to be found at all times in small numbers. There was no time of day when they appeared in quantities, as is the habit of zoospores of members of the Chlorophyceæ, although they exhibited the same phenomena of collecting on the sides of the vessel nearest the light. When confined in a Van Tieghem cell they swarm about for a day or two, finally coming to rest at the edge of the drop of water.

The cells (plate XI, fig. 1) are broadly elliptical in outline, from 8–10μ long and 5–6μ wide. One end is slighly truncate in shape and contains a slight depression into which the pair of cilia are inserted. The cilia are not the same length, the longer being about as long as the cell is wide and the other somewhat shorter. They are so placed, and the figure illustrates this point, that the longest cilium is nearest to the longest axis of the cell.

Inside the cell are from six to ten disc-shaped bodies arranged around the periphery of the cell. These bodies are not pyrenoids, nor are they amorphous albuminous matter, for they are readily destroyed by a dilute potassic hydrate solution after long treatment in mercuric chloride in absolute alcohol. For this reason it seems as though these bodies are true chromatophores, although the blue-green tint is not always confined to them. Sometimes the blue-green color seems to fill almost the entire cell, only the end which bears the cilia being hyaline.

Near the middle of the cell on the periphery are one or often two bright red pigment spots: when two they are always placed near together, sometimes almost touching. The presence of the two pigment spots in one individual did not seem to indicate that conjugation had taken place, for such specimens were not necessarily larger in size and no specimen was ever observed with four cilia.

At the opposite end of the cell from the cilia there is usually to be found a light colored area that probably marks the position of the nucleus, which was demonstrated to be present in the non-motile cells.

The motion of the motile cells through the water is quick and sometimes they dart to one side in a manner that suggests at once the motion of certain infusoria. They come to rest slowly, moving occasionally from side to side some time after they seem to have settled down. While they sometimes spin around on the ciliated end just before they settle down, they do not attach themselves in a perpendicular position but rest on one side. The length of time these cells remain in the motile condition, and the character of their movements, forms a striking contrast to the motile phases of other algæ, such as Cladophora, Draparnaldia, Ulva, etc., whose zoospores settle down within a few hours to develop a new individual.

Non-motile stage.

The motile cells when they came to rest in a Van Tieghem cell, did not divide for two or three days and after that only at intervals of two or three days. The division consists of a longitudinal splitting of the cell into a pair of similar cells and hence in the colonies they tend to show a pretty regular arrangement in groups of twos and fours. They are about the same size as the motile cells but inclined to be a little shorter and somewhat broader in their proportions. That there is a common gelatinous envelope surrounding young colonies is often clearly shown by the quantities of bacteria that swarm at a fixed distance from the cells (plate XI, fig. 2). This gelatinous envelope is not a marked character however and in large colonies it is quite insignificant (plate XI, fig. 3), although it is not difficult to prove its existence with proper stains.

The chromatophores, in the non-motile cells, are not arranged in any regular manner and sometimes the entire cell appears of an almost uniform blue-green tint. The chromatophores vary in size but are usually discoid in shape, (plate XI, fig. 4). They may be brought out with great distinctness in cells after treatment with absolute alcohol, and appear perfectly homogeneous.

One or two, and rarely three, pigment spots are to be found near the middle of the cells on the periphery. Their color however is not so bright as in the motile stage but inclined to be a brownish-red.

A well defined nucleus (plate XI, fig. 5) can easily be demonstrated when specimens, well fixed and hardened, are treated with dilute potassic hydrate solution to destroy the chromatophores and then stained with eosin.

In several instances, while examining under the microscope the colonies scraped from the marsh grass, single cells were observed to slip out from the colony and swim away and these were identical with the blue-green motile cells.

Taxonomy.

The presence of a well defined nucleus, pigment spots and chromatophores clearly showed that this form was not a member of the Myxophyceæ as the group is defined by most botanists.

Of late there has been considerable discussion on the inner structure of the cells of Myxophyceæ, particularly in respect to the possible occurrence of nuclei and chromatophores. Almost all the investigators in this field of research agree in saying that there never exists a nucleus in the usual sense of the word; that, if present at all, it is in the form of some central body of very indefinite outline, or scattered through the cell in the shape of small granules which react with stains in a manner similar to the chromatin bodies in the nuclei of higher plants. The nucleus in the present form is perfectly well defined and contains a distinct nucleolus. In regard to the presence of chromatophores in the cells of Myxophyceæ there is less unanimity of opinion among recent writers. Several investigators, Hieronymus, Zukal, and others, believe that chromatophores exist; but other investigators, Zacharias in particular, have not been able to find them. The chromatophore of Hieronymus is present as a network just under the cell wall and is only made apparent by special treatment. No investigator appears to have seen bodies as definitely organized and outlined as the chromatophores in the cells of the form that has just been described. For a general review of the literature on this subject the reader is referred to a paper by Flahault in the Revue gén. de Botanique **5**: 181. 1893.

Blue-green motile cells have been known for a long time. Ehrenberg[5] in 1838 published an account of three species under the genera *Cryptomonas* and *Cryptoglena* and since then very little has been added to our systematic knowledge of these forms. The genus *Cryptoglena* was distinguished from *Cryptomonas* by Ehrenberg because of its pigment spot, and

[5] Ehrenberg, Die Infusionsthierchen als vollkommene Organismen. 1838.

therefore the present form clearly belongs to *Cryptoglena*, as defined by Ehrenberg, but no species of Ehrenberg agrees with it in measurement nor does it resemble any of Ehrenberg's figures. Moreover, none of Ehrenberg's species were marine.

Under the name *Cryptomonas polymorpha*, Perty[6] has included all the blue-green forms of Ehrenberg as well as some grass-green forms, but his uniting so many various forms under one name does not seem to be warranted and has not been generally accepted by recent writers. Stein[7] gives an account of the structure of a form he calls *Cryptomonas ovata* Ehrenb.; but, as Hansgirg[8] has shown, his form cannot be the same as Ehrenberg's *Cryptomonas ovata* for the latter is grass-green and has only one cilium, while Stein's form is blue-green and has two cilia. Cienkowsky,[9] previous to Stein's publication, had minutely described a form, calling it *Cryptomonas ovata*, which is evidently much the same form as Stein's *Cryptomonas ovata*. More recently Dangeard[10] has given a description of *Cryptomonas ovata* and his seems also to be the same as that of Cienkowsky and Stein. This form, studied by Dangeard, Stein and Cienkowsky, is very different from that which I have found. Their species has no pigment spot, no bodies corresponding to the chromatophores in my form, it is much larger and the cell shows a degree of complication far greater than is found in the one here described.

Dangeard[11] has also described a new blue-green motile cell, *Cryptomonas cyana*, which is very small (3–4μ long), and quite recently[12] he mentions having observed a marine *Cryptomonas* (*C. marina*), but the description is too short to enable me to judge whether or not it is similar to the present organism. A species that closely resembles my form in measurements, has been described by Hansgirg[13] as *Chroomonas Nordstedtii*, but this species differs in having no pigment spots and in the shape of the chromatophore which is lamina-like with pyrenoids 3μ wide.

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[6]Perty, Zur Kennt. kleinster Lebensf. nach Bau. Funk. System. etc., 1852.

[7]Stein, Der Organismus der Infusionthiere. III Abtheilung, I Hälfte. *pl. 19. fig. 26.* 1878.

[8]Hansgirg, Bot. Centralblatt. **24:** 342. 1885.

[9]Cienkowsky, Ueber Palmellaceen und einige Flagellaten. Archiv f. mikr. Anat. **6:** 424. *pl. 23.* 1870.

[10]Dangeard, Contribution a l'étude des organismes inférieurs. Le Botaniste II.—:47. 1890.

[11]Dangeard, l. c., p. 54.

[12]Dangeard, Note sur un Cryptomonas marin. Le Botaniste III.—:—1892.

[13]Hansgirg, Bot. Centralblatt **23:** 230. 1885.—**24:** 376. 1885.

As the presence of pigment spots, character of the chromatophores and general simplicity of the cell distinguish the form here described from the genus Cryptomonas as understood by Dangeard, Stein, Cienkowsky, and primarily by Ehrenberg, it has seemed best to adopt the name Cryptoglena with the character of the genus as defined by Ehrenberg, and as no described species appears to be like the present form, it seems desirable to publish its description as:

Cryptoglena Americana, sp. nov.—Motile cells broadly elliptical, 8–10μ long, 5–6μ wide: cell contents blue-green with 6–10 disc-shaped chromatophores arranged around the periphery: one or two bright red pigment spots placed on the periphery near the middle of the cell: one end hyaline, slightly truncate, with a depression from which arise a pair of cilia of unequal length, the longer about as long as the cell is wide.

Non-motile cells slightly shorter and somewhat broader than motile cells (7–9μ long $\times$ 6–7μ wide), arranged in groups of twos and fours in a closely packed Polycystis-like colony: almost uniformly colored, blue-green, with 6–10 disc-shaped chromatophores and one or two brownish red pigment spots near the middle of the cell at the periphery: nucleus near the middle of the cell.

Habitat: salt marshes of the Charles river, Cambridge, Mass., on stems of grass and larger algæ. Autumn.[14]

The agreement in measurements between the non-motile cells of *Cryptoglena Americana* and the cells of the American form of *Polycystis pallida*, described by Dr. Farlow,[15] is very interesting and suggests the possibility that this *Polycystis pallida* is really the non-motile condition of this species of Cryptoglena. I have had the opportunity of comparing herbarium specimens of the American *Polycystis pallida* with European specimens of the same species and they seem to be identical.

Herbarium speeimens of *Polycystis pallida* give very little evidence of a cell structure as differentiated as *Cryptoglena Americana*, but specimens of *Cryptoglena Americana* after being dried on mica for a month gave very little indication of the chromatophores and no indication of the pigment spots.

[14]The motile condition appears to be common all through the winter. It has frequently been met with since the above was written.

[15]The marine algæ of New England 28, 1879.

The question of a possible identity of these two forms can only be settled by an examination of fresh material of *Polycystis pallida* and it is desirable that botanists who have the opportunity of investigating this point should bear the question in mind.

Cambridge, Mass.

EXPLANATION OF PLATE XI.

All figures sketched with an Abbé camera and magnified about 750 diameters; reduced in engraving one-tenth.

Fig. 1, Motile cells, killed with Flemming's fluid.—Fig. 2, A young colony of non-motile cells; the boundary of a surrounding gelatinous envelope is marked by the swarm of bacteria.—Fig. 3, A colony of non-motile cells.—Fig. 4, Four non-motile cells after treatment with absolute alcohol, showing chromatophores.—Fig. 5, Two non-motile cells, after treatment with dilute potassic hydrate solution, and staining with eosin, showing nuclei.

Flowers and insects. XII.

CHARLES ROBERTSON.

CLEMATIS VIRGINIANA L.—The flower, with its horizontally expanded sepals, measures about 2^{cm} across. The flower clusters form large, white masses upon the shrubs upon which the plants climb. The flowers are dioecious. The white color and the easily accessible nectar attract numerous, mostly small, short-tongued insects. The visitors, however, are principally flies, three-fifths of the species being of this kind.

An interesting comparison may be made between this plant and *Isopyrum biternatum*, an account of which is given in the GAZETTE, **17**: 173–5. 1892. The flowers of both species are white, though the Clematis is more conspicuous, and the extent of nectar concealment is almost identical. Nevertheless, the species show a marked difference in the kinds of insects visiting them, as the following table will show:

	BEES.	OTHER HYMENOP.	SYRPHIDÆ.	TACHINIDÆ.	MUSCIDÆ.	OTHER DIPTERA.	OTHER INSECTS.	TOTAL.
Isopyrum biternatum	31	0	10	1	1	2	5	50
Clematis Virginiana	9	10	6	10	7	11	2	55

The difference is mainly a result of the time of blooming. Isopyrum, according to my observations, blooms from March 24th to May 12th, and Clematis Virginiana from July 11th to Aug. 16th. During the blooming time of the former, bees are almost as abundant as during the blooming time of the latter. Of the lower aculeate Hymenoptera I have never seen in my neighborhood more than six species during the period of Isopyrum, though they become more abundant about the time the plant goes out of bloom; but they reach their maximum during the period of Clematis Virginiana, within which time I have noted 115 species flying simultaneously.

Then Isopyrum is exposed to a tachinid fauna of only six species also, while the Clematis is exposed to thirty or more species. The *Muscidæ* are also more abundant while Clematis Virginiana is in bloom. It seems that bees and *Syrphidæ*, therefore, are less abundant on the Clematis on account of the competition of the lower Hymenoptera and the other Diptera.

As far as I have observed in my neighborhood, this is the latest blooming of the Ranunculaceæ. By late blooming it gains the signal advantage of avoiding competition with such allies as Ranunculus, Isopyrum, Anemonella, etc., and it finds the general anthophilous insect fauna at its maximum. Its period overlaps with the periods of *C. Pitcheri* and *Anemone Virginiana*. *C. Pitcheri*, its congener, is hardly a competitor, since, as observed below, it is adapted to bumble-bees. The Anemone, being a pollen flower, also avoids competition to some extent by attracting a different set of insects.

The following insects were taken from the staminate flowers on July 27th, 28th, 30th and August 3d:

HYMENOPTERA.—*Apidae*: (1) Apis mellifica L. ☿, s.; (2) Bombus virginicus Oliv. ☿, s. and c. p.; *Andrenidae:* (3) Halictus zephyrus Sm. ♂♀, s. and c. p.; (4) H. confusus Sm. ♂♀, s. and c. p.; (5) H. stultus Cr. ♂♀, s. and c. p., the most abundant visitor; (6) H. cressonii Rob. ♂; (7) Sphecodes arvensis Pttn. ♂, s.; (8) S. confertus Say ♀, s.; (9) Prosopis affinis Sm. ♂♀, s.; *Eumenidae:* (10) Odynerus tigris Sauss., s.; (11) O. foraminatus Sauss., s.; *Crabronidae:* (12) Crabro minimus Pk., s.; (13) C. interruptus Lep., s.; (14) Oxybelus 4-notatus Say, s.; *Nyssonidae:* (15) Nysson plagiatus Cr., s.; *Sphecidae:* (16) Pelopoeus cemenrarius Dru., s.; (17) Isodontia philadelphica Lep., s.; (18) Sphex ichneumonea L., s.; *Scoliidae:* (19) Scolia bicincta F., s.

DIPTERA.—*Conopidae:* (20) Oncomyia loraria Lw., s.; *Syrphidae:* (21) Platychirus quadratus Say; (22) Allograpta obliqua Say; (23) Mesograpta marginata Say; (24) Sphaerophoria cylindrica Say; (25) Eristalis transversus Wd.; (26) Syritta pipiens L.; *Tachinidae:* (27) Exorista sp.; (28) Loewia globosa Twns.; (29) Hyalomyia purpurascens Twns.; (30) Jurinia apicifera Wlk.; (31) J. smaragdina Mcq.; (32) Micropalpus fulgens Mg.; (33) Frontina flavicauda Riley; (34) Siphona illinoensis Twns.; (35) Miltogramma argentifrons Twns.; (36) Sarcomacronychia aurifrons Twns.; *Sarcophagidae:* (37) Sarcophaga sp.; *Muscidae:* (38) Calliphora erythrocephala Mg.; (39) Graphomyia sp.; (40) Lucilia sp.; (41) L latifrons Schin.; (42) L. cornicina F.; (43) Compsomyia macellaria F.; (44) Musca domestica L.; *Anthomyidae:* (45) Homalomyia canicularis L.; (46) Anthomyia albicincta Fll.; (47-48) Chortophila spp.; *Sepsidae:* (49) Sepsis sp.; *M. acalyptratae:* (50-53) spp.—all sucking.

LEPIDOPTERA.—*Lycaenidae:* (54) Lycaena pseudargiolus B.-L., s.

HEMIPTERA.—*Capsidae:* (55) Lopidea media Say, s.

CLEMATIS PITCHERI Torr. and Gray.[1]—In this case we have a bumble-bee flower produced by a very simple modification. The sepals, instead of being expanded horizontally so as to admit all sorts of insects to the pollen produced in the anthers, and to the nectar secreted by the filaments, are thick and rigid and have their edges so closely approximated that bees are only admitted at the small opening formed by their separating tips.

The flower is nodding and is purplish exteriorly. It measures about 2^{cm} long and opens to the extent of 5^{mm}. The tips of the sepals are pointed and reflexed, so as to form foot-holds for the visiting bumble-bees. As observed above, nectar is secreted by the filaments. After a bee has inserted its head as far as it will go, it still needs a proboscis from 12 to 15^{mm} long to exhaust the nectar supply.

In newly opened flowers, the stigmas are so far advanced (4^{mm}) before the anthers that cross-pollination very readily occurs by the bees touching them before disturbing the pollen. Later, when the inner anthers dehisce, spontaneous self-pollination may occur by these anthers, which finally equal the stigmas, coming in contact with the latter.

I have seen the flowers visited for nectar by *Bombus vagans* Sm. ♀, and by *Volucella vesiculosa* F.

RANUNCULUS SEPTENTRIONALIS Poir.—The plant is common, growing in scattered patches in low, rich soil. At first the flowers rise 1 or 2^{dm}, the stems finally elongating so as to hold them above the surrounding grass. The spreading stems bear only a few open flowers at a time, which renders them less conspicuous, but increases the probability of cross-pollination between flowers of distinct plants.

[1] This plant resembles *C. Viorna*, which is described and figured by Foerste in Am. Nat. 19: 397. 1885.

The bright yellow petals expand horizontally, the flower measuring 2 or 3^{cm} across.

The flower is proterogynous. The styles elongate, holding their receptive stigmas above the anthers, which at first are all closed. The outer stamens lengthen and discharge first, the dehiscence being extrorse.

There is abundant opportunity for cross-pollination before the anthers begin to discharge. Later cross- or self-pollination may occur by insect aid. There is no doubt that self-pollination depends mainly upon the visits of insects. If, however, the stigmas remain untouched until the inner anthers discharge, spontaneous self-pollination may occur by pollen falling upon the stigmas, since the inner filaments finally lengthen so as to hold the dehiscent anthers over the stigmas. The plant was observed in bloom from April 8th to May 24th. On six days, between April 16th and May 7th, the following list of visitors was observed:

HYMENOPTERA.—*Apidæ:* (1) Synhalonia belfragei Cr. ♂, s.; (2) Ceratina tejonensis Cr. ♂, s.; (3) C. dupla Say ♂♀, s. and c. p., ab.; (4) Osmia albiventris Cr. ♂♀, s. and c. p., ab.; (5) O. conjuncta Cr. ♀, c. p.; (6) O. lignaria Say ♀, s. and c. p.; (7) O. cognata Cr. ♂, s.; *Andrenidæ*: (8) Andrena polemonii Rob. ♂♀, s. and c. p., ab.; (9) A. cressonii Rob. ♀, s. and c. p.; (10) A. ziziæ Rob. ♂, s.; (11) Augochlora labrosa Say ♀, s.; (12) A. pura Say ♀, s. and c. p., ab.; (13) Halictus 4-maculatus Rob. ♀, s.; (14) H. pectoralis Sm. ♀, s. and c. p.; (15) H. coriaceus Sm. ♀, s. and c. p.; (16) H. lerouxii Lep. ♀, s. and c. p.; (17) H. ligatus Say ♀, s. and c. p.; (18) H. fasciatus Nyl. ♀, s. and c. p.; (19) H. pilosus Sm. ♀, s. and c. p.; (20) H. obscurus Rob. ♀, s. and c. p.; (21) H. stultus Cr. ♀, s.; (22) H. zephyrus Sm. ♀, s.; (23) Sphecodes dichroa Sm. ♂, s.

DIPTERA.—*Bombylidæ:* (24) Bombylius pulchellus Lw., s., one; (25) B. fratellus Wd., s.; *Syrphidæ:* (26) Pipiza pistica Will., f. p.; (27) P. femoralis Lw., f. p.; (28) Chilosia capillata Lw., s. and f. p., ab.; (29) Melanostoma obscurum Say, s. and f. p.; (30) Syrphus ribesii L., s. and f. p.; (31) S. americanus Wd., s. and f. p.; (32) S. arcuatus Fll., f. p.; (33) Mesograpta geminata Say, f. p.; (34) Sphærophoria cylindrica Say, f. p.; *Tachinidæ:* (35) Siphona illinoensis Twns., s.; *Muscidæ:* (36) Cyrtoneura sp.; *Anthomyidæ:* (37) Hydrophoria sp., s.; (38) Homalomyia sp., s; (39–40) Anthomyia spp., s.; (41–42) Chortophila sp., s.

COLEOPTERA.—*Carabidæ:* (43) Lebia viridis Say; *Coccinellidæ:* (44) Megilla maculata DeG., f. p.; *Chrysomelidæ:* (45) Diabrotica vittata F., f. p.; *Œdemeridæ:* (46) Asclera ruficollis Say, f. p.; *Anthicidæ:* (47) Corphyra terminalis Say, f. p.; *Curculionidæ:* (48–49) Centrinus spp., f. p.

LEPIDOPTERA.—*Hesperidæ:* (50) Nisoniades juvenalis F., s.; (51) N. brizo B.-L., s.; (52) Eudamus bathyllus S.-A., s.

RANUNCULUS FASCICULARIS Muhl.—This is the common early buttercup, blooming from March 24th to May 19th. The stems rise about 1^{dm}. Each plant commonly shows only one or two open flowers at a time, so that in this case pollination between distinct plants is apt to occur; but well developed plants often show several flowers, when pollination is more likely to take place between flowers of the same plant.

The flowers are bright yellow, expanding from 15 to 25^{mm}. Newly opened flowers are less widely spread. They show the indehiscent anthers crowded in a compact mass, and the stigmas surpassing them by 1–2^{mm}. At this time, the stigmas are receptive, and I have often found them thoroughly dusted with pollen which must have come from other flowers. The flowers are therefore proterogynous and are generally cross-pollinated. In older flowers the petals are lengthened and more expanded. The stamens also lengthen and finally overtop the stigmas, the anthers nearly concealing them. At this time, if fertilization has not already taken place, spontaneous self-pollination may readily occur by the stigmas receiving pollen from the anthers which now overtop them, and often touch them, as in the preceding.

On account of its earlier blooming, its more scattered habit, and the more exposed situations in which it grows, R. fascicularis is not so abundantly visited by insects as is the case with R. septentrionalis, though it shows a very similar list.

The following visitors were observed on six days, between April 11 and May 5:

HYMENOPTERA.—*Apidæ:* (1) Apis mellifica L. ☿, s.; (2) Ceratina tejonensis Cr. ♂, s.; (3) C. dupla Say ♂♀, s., freq.; (4) Osmia albiventris Cr. ♂♀, s., freq.; (5) Nomada sayi Rob. ♂, s.; *Andrenidæ:* (6) Andrena violæ Rob. ♂, s.; (7) A. cressonii Rob. ♀, s.; (8) A. flavo-clypeata Sm. ♂, s.; (9) Halictus pectoralis Sm. ♀, s. and c. p.; (10) H. coriaceus Sm. ♀, s.; (11) H. ligatus Say ♀, s. and c. p.; (12) H. fasciatus Nyl. ♀, s. and c. p.; (13) H. pilosus Sm. ♀, s.; (14) H. confusus Sm. ♀, s., freq.; (15) H. pruinosus Rob. ♀, s. and c. p.; (16) H. stultus Cr. ♀, s.; (17) Augochlora pura Say ♀, s. and c. p., freq.; (18) Agapostemon radiatus Say ♀, s. and c. p., freq.

DIPTERA.—*Bombyliidæ:* (19) Bombylius fratellus Wd., s.; *Syrphidæ:* (20) Chilosia capillata Lw., s.; (21) Melanostoma mellinum L.; (22) Syrphus arcuatus Fll., s.; (23) S. americanus Wd.; (24) Mesograpta marginata Say, s. and f. p., freq.; (25) M. geminata Say, s., freq.; (26) Sphaerophoria cylindrica Say, s. and f. p.; (27) Eristalis transversus Wd., f. p.; (28) Xylota fraudulosa Lw.. s.; *Tachinidæ:* (29) Gonia frontosa Say, s., freq.; *Sarcophagidæ:* (30) Sarcophaga sp., s.; *Muscidæ:* (31) Lucilia cornicina F., s.; *Anthomyidæ:* (32) Chortophila sp., s., freq.

LEPIDOPTERA.—*Papilionidæ:* (33) Colias philodice Godt., s.

COLEOPTERA.—*Œdemeridæ:* (34) Asclera ruficollis Say, f. p.

RANUNCULUS ABORTIVUS L.[2]—Although apparently in need of a chance to pollinate its stigmas with pollen from its own stamens, as in the cases of R. fascicularis and septentrionalis, the flowers of this species do not seem to be able to effectually self-pollinate.

Newly opened flowers have receptive stigmas before the anthers dehisce and are consequently proterogynous. Soon the outer anthers begin to dehisce extrorsely and early become reflexed. At this time the central carpels are above and entirely out of reach of the anthers. Later the stamens lengthen, but then the same carpels are still removed by the elongation of the receptacle. The lower pistils, however, may receive pollen directly from the surrounding anthers, when these have dehisced.

The stems grow from 1–4^{dm} high, and bear numerous small flowers about 5–8^{mm} wide. The petals are minute, and bear nectar pits on their bases, not protected by a scale. Although the flowers are quite inconspicuous, as compared with the two preceding species, under favorable conditions they attract insects in sufficient numbers to insure cross-pollination. But it would take long and patient watching to make out a list equal to the lists of either R. septentrionalis, or fascicularis. On the 5th of May I noted as visitors:

HYMENOPTERA.—*Andrenidae:* (1) Andrena ziziae Rob. ♂, s., freq.; (2) Halictus stultus Cr. ♀, s. and c. p.; (3) Augochlora pura Say ♀, s.

[2]See Meehan: Contributions to the Life-Histories of Plants, VII., Proc. Acad. Nat. Sci. Philad., 1892.

COLEOPTERA.—*Coccinellidae:* (4) Megilla maculata DeG., f. p.; (5) Coccinella 9-notata Hbst., s.

The three species of Ranunculus, an account of which has been given above, are in competition with one another and with other members of the genus, as well as with other members of the order, such as Isopyrum, Anemonella, Myosurus, Hydrastis, etc. In the period from the latter part of April to the middle of May, which is the maximum period of Ranunculaceæ, *Delphinium tricorne* and *Aquilegia Canadensis* are also in bloom, but they can hardly be regarded as competitors, since the former is adapted to bumble-bees and the latter to humming-birds. [3]

HYPERICUM CISTIFOLIUM Lam.—The stems grow from 3-6^{dm} high and are often collected in rather conspicuous patches. The flowers appear in many-flowered cymes, are yellow, and expand about 15^{mm}. Of the numerous stamens the inner dehisce first, rising to the centre. The flowers are homogamous, with a chance of self-pollination. The homogamy, however, does not exist as a provision for self-pollination, though under certain conditions, it may be of advantage for this purpose; but is correlated with the fact that the flowers are devoid of nectar, and are visited exclusively for pollen.

Homogamy is a common characteristic of pollen-flowers, as well as of many highly organized flowers which secrete nectar and yield abundant pollen. The fact is that dichogamy acts disadvantageously in all cases in which a numerous set of visitors come exclusively for pollen, for these visitors neglect the flowers which are in the pistillate stage.

Hypericum cistifolium depends almost exclusively on bumble-bee females and workers, which visit it to collect pollen. On seven different days I noted them thus engaged. The species were: (1) *Bombus americanorum* F. ♀☿, ab.; (2) *B. pennsylvanicus* DeG. ☿; (3) *B. separatus* Cr. ♀☿, ab. On one occasion I saw the pollen collected by *Agapostemon bicolor* Rob. ♀. The flowers bloom from June 18 to July 22.

XANTHOXYLUM AMERICANUM Mill.—The northern prickly ash blossoms in early spring, and its blooming time is of short duration, Apr. 12th to 28th. The shrubs grow in small clumps and rise from 1–2^{m}. The greenish flowers are in small umbel-like clusters and are no more conspicuous than the young leaves

[3] See Todd: Am. Nat. **14**: 668, and Trelease: ibid., 731.

with which they appear; but insect visits are secured by abundant nectar secreted by the large gynobase. The corolla forms a loose tube about 2^{mm} long, beyond the tip of which the entire length of the conniving styles is exserted. The ovaries and the gynobase each occupy about half of this tube. The elevation of the ovaries gives them the novel function of obstructing the tube and to some extent concealing the nectar, and the most convenient passages to the nectar are the intervals between them. In the staminate flowers the gynobase is developed into a more widely expanded disc, with lobes extending between the filaments. In this form the nectar is concealed by the filaments and by the rudimentary ovaries. Access to it is most convenient between the filaments. Cross-fertilization between distinct plants is secured by dioecism. In spite of the inconspicuousness of the flowers abundant insect visits are insured.

This is a good illustration of the value of nectar as an entomophilous character of flowers. The secretion of nectar is, as a rule, all that is necessary to induce insect visits to flowers in natural situations and under fairly favorable conditions, and I am in the habit of disregarding the opinion that flowers are not frequently visited by insects in all cases where I am satisfied that nectar is secreted. When nectar alone is such an effective agent in securing insect visits the fact that flowers display even the least advertisement in the way of conspicuously colored parts is conclusive proof of the extreme importance of insect aid.

The following visitors of Xanthoxylum were taken on four days, between Apr. 12th and 19th:

HYMENOPTERA.—*Apidæ:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Ceratina tejonensis Cr. ♂, s.; (3) Osmia lignaria Say ♂♀, s., ab.; (4) O. albiventris Cr. ♂, s., ab.; (5) Nomada luteola Lep. ♂♀, s., ab.; (6) N. maculata Cr. ♂♀, s., ab.; *Andrenidæ:* (7) Andrena sayi Rob. ♂, s., ab.; (8) A. pruni Rob. ♂♀, s., freq.; (9) A. cressonii Rob. ♂♀, s., ab.; (10) A. flavo-clypeata Sm. ♂♀, s., ab.; (11) A. rugosa Rob. ♂, s.; (12) A. mariæ Rob. ♂, s.; (13) A. claytoniæ Rob. ♂♀, s., ab.; (14) Halictus sp. ♀, s.; (15) H. gracilis Rob. ♀, s., freq.; (16) H. arcuatus Rob. ♀, s.: (17) H. lerouxii Lep. ♀, s.; (18) H. ligatus Say ♀, s.; (19) H. cressonii Rob. ♀, s.; (20) H. zephyrus Sm. ♀, s., freq.; (21) H. caeruleus Rob. ♀, s., freq.; (22) H. confusus Sm. ♀, s., freq.; (23) H. stultus Cr. ♀, s. and c. p., ab.; (24)

Augochlora pura Say ♀, s.; (25) Colletes inæqualis Say ♂♀, s., ab.

DIPTERA.—*Syrphidæ:* (26) Chrysogaster nitida Wd.; (27) Syrphus americanus Wd.; (28) Xanthogramma felix O. S.; (29) Mesograpta geminata Say; (30) Sphærophoria cylindrica Say; (31) Eristalis dimidiatus Wd.; (32) Helophilus similis Mcq.; *Tachinidae:* (33) Jurinia apicifera Wlk.; (34) Gonia exul Will., ab.; (35) G. frontosa Say, ab.; *Muscidae:* (36) Lucilia cæsar L.; (37) L. cornicina F. freq.; *Cordyluridae:* (38) Scatophaga squalida Mg.—all sucking.

LEPIDOPTERA.—*Noctuidae:* (39) Plusia simplex Gn., s.

RHUS GLABRA L. — The greenish-yellow flowers are crowded in dense terminal panicles. Each flower forms a broad, shallow cup, in the bottom of which is situated a broad, yellow, five-lobed disc, which secretes nectar. In the pistillate flower access to the disc is impeded only by the style with its three large stigmas, and by small tufts of hairs on the inner faces of the five petals. In the staminate flower the disc is somewhat concealed by the large anthers.

As far as observed this species seems to be diœcious. In the patch of plants on which most of the insects were taken I found only pistillate flowers. I have also found patches in which all of the flowers appeared to be staminate, and in which, after the flowers fell, no fruit was to be seen, but only the naked axes of the panicles.

I have noted the flowers in bloom from June 8th to 24th. On account of the convenient nectar they are visited by numerous insects, mostly short-tongued Hymenoptera and Diptera, as shown in the following list, which contains insects noted on the flowers on three days, June 22d to 24th.

HYMENOPTERA.—*Apidae:* (1) Apis mellifica L. ☿, s., ab.; (2) Ceratina dupla Say ♀, s. and c. p.; (3) Heriades carinatum Cr. ♂♀, s. and c. p.; *Andrenidae:* (4) Andrena crataegi Rob. ♀, s.; (5) Halictus arcuatus Rob. ♀, s. and c. p., ab.; (6) H. parallelus Say ♀, s.; (7) H. lerouxii Lep. ♀, s.; (8) H. fasciatus Nyl. ♀, s.; (9) H. pilosus Sm. ♀, s. and c. p.; (10) H. pruinosus Rob. ♂♀, s.; (11) H. confusus Sm. ♂♀, s. and c. p., ab.; (12) H. zephyrus Sm. ♀, s. and c. p.; (13) H. stultus Cr. ♀, s. and c. p., ab.; (14) Augochlora pura Say ♀, s. and c. p.; (15) Agapostemon bicolor Rob. ♀, s. and c. p.; (16) A. radiatus Say ♀, s.; (17) Colletes willistonii Rob. ♂♀, s., freq.; (18)

C. eulophi Rob. ♂♀, s., freq.; (19) Prosopis affinis Sm. ♂, s. and f. p.; *Vespidae:* (20) Polistes metricus Say, s.; *Eumenidae:* (21) Odynerus anormis Say, s.; *Crabronidae:* (22) Oxybelus frontalis Rob., s.; (23) O. emarginatus Say, s.; *Mimesidae:* (24) Mimesa proxima Cr., s.; *Philanthidae:* (25) Cerceris robertsonii Fox, s., freq.: (26) C. compacta Cr., s., freq.; *Sphecidæ:* (27) Ammophila gryphus Sm., s.; (28) A. vulgaris Cr., s.; (29) Isodontia philadelphica Lep., s.; (30) Priononyx thomæ F., s.; *Pompilidae:* (31) Pompilus marginatus Say, s.; *Braconidae:* (32) Vipio robertsonii Ashm. (MS.), s.

DIPTERA.—*Empidae:* (33) Empis sp., s.; *Conopidae:* (34) Physocephala tibialis Say, s.; (35) Zodion nanellum Lw., s.; *Syrphidae:* (36) Syrphus ribesii L., s. and f. p.; (37) S. americanus Wd., s. and f. p.; (38) Mesograpta marginata Say, s. and f. p., freq.; (39) M. geminata Say, s. and f. p.; *Tachinidae:* (40) Ocyptera euchenor Wlk., s.; (41) Jurinia apicifera Wlk., s., ab.; (42) J. smaragdina Mcq., s.; (43) Belvosia bifasciata F., s.; (44) Trichophora echinomoides Twns., s.; (45) Sarcomacronychia aurifrons Twns., s.; (46) Masicera sp., s.; (47) Acroglossa hesperidarum Will., s.; *Sarcophagidae:* (48) sp., s.; (49–52) Sarcophaga spp., s.; *Muscidae:* (53) Stomoxys calcitrans L., s.; (54) Lucilia cornicina F., s.; (55) L. sylvarum Mg., s.; *Anthomyidae:* (56–57) Chortophila spp., s.

COLEOPTERA.—*Mordellidae:* (58) Mordella marginata Melsh., s.

Carlinville, Ill.

An auxanometer for the registration of growth of stems in thickness.

KATHERINE E. GOLDEN.

WITH PLATES XII AND XIII.

Description of the instrument.

The main feature of this auxanometer for measuring growth in thickness (see plate XII) is a balanced glass arm supported near one end, acting as a multiplying lever. The longer part of the arm has a bristle fastened at the end that registers the lateral movement upon one or more blackened glass rods carried round on a brass spool, the spool being revolved by a clock.

The glass arm passes through a short brass tube held between two hardened steel points. The position of the arm is varied by changing the brass Y, holding the points, which is kept in place by a set screw. The longer arm is counterbalanced by a weight suspended from the shorter arm. Close behind the steel points is a small fork; this fork presses the stem to be measured upon one side, and the glass arm upon the other. The fork is made at the end of a screw thread, to admit of movement backward and forward, to accommodate large or small stems. To keep the long glass tube straight a fine wire is stretched from one end to the other, passing over a support, thus forming a truss. These pieces of mechanism are held in place by a long wooden beam, supported on three feet placed near one end, one of which is provided with a levelling screw to admit of adjustment for plants of varying height. The spool is made to revolve by having the axis extended at one end beyond its supports to carry a grooved pulley, which is connected with a similar grooved pulley, attached to the hour hand spindle of the clock, by means of a small rubber band. The friction between the rubber and the grooved pulleys, and the uniform tension, preclude slipping.

The instrument is used by placing the stem of the plant between the fixed fork and the short arm of the glass rod. Perfect contact of the glass arm and the stem of the plant is maintained by means of a very light wire spring fastened between the beam and the glass arm (not shown in the illustration).

The distance between the point of contact with the plant and the pivot is one-fortieth of the distance from the blackened glass rod to the pivot, so that any growth of the plant is magnified forty times on the blackened rod. Thus a growth of one-thousandth of an inch will be represented by one-twenty-fifth of an inch on the blackened rod.

From the blackened glass rod a permanent record can be obtained by making a print of it on sensitized paper, from which direct measurements can be made.

The instrument was devised and made by my brother, M. J. Golden, professor of practical mechanics in Purdue University.

The following observations are given to show the work done by the apparatus.

Record of experiments.

The study of growth in length has received a great deal of attention from many physiologists, notably Sachs. He has found that there is a maximum and a minimum point of growth, and also that there are forms of growth for which no reason, as yet, has been assigned, these latter being termed "spontaneous variations." Growth in length has been studied for small as well as large plants, but in no recorded case has growth in thickness been studied upon any but large plants, and in these the measurements were made by the observer at intervals of time with some calipering instrument, thus introducing a possible error due to the personal equation. The periodicity of growth has been determined for growth in length, but has been assumed for growth in thickness, largely as a result of measurements of growth in length and as an accompaniment to it.

The amount of tension is one of the principal factors in growth, as there is little growth when the tension is low, and greatest growth when the tension is high. Kraus[1] has found in his measurements on stems of trees that there is a maximum and a minimum point of tension, these occurring at about the same time that the maximum and minimum points of growth have been found to occur by other investigators. But he states that he has found that temperature has very little effect on tension for the ordinary variations occur between 10–30°C. In his experiments on the tension of stems his

[1] Kraus, G., Die tägliche Schwellungsperiode der Pflanzen 28.

figures show the greatest tension when the temperature was the lowest at 2 A. M., while the tension is lowest at 1 P. M. when the temperature was 2° short of the highest point it had attained in two days.

Millardet[2] has verified the statements of Kraus with respect to the periodicity of tensions, working with *Mimosa pudica*, but he has found that a rise of temperature increases the tension, while a fall of temperature diminishes it. Kraus' measurements were made upon stems of trees (maple, birch, and oak) that would not show the effect of temperature readily, while Millardet's were made upon the stem, petiole, and leaf of a plant that would easily show small differences of tension. The subject of tension in tissues is very important as each separate tissue has its own rate of growth, causing tensions to be set up in the various tissues. In measuring stems one has to determine whether an increase in the thickness is temporary, and due only to tension, or a permanent increase due to growth. If it be tension only, a decrease in thickness will follow the increase, this being caused by a contraction of the tissues.

The plants used for the following work were tomatoes and potatoes, these being good growers in thickness as well as length, and having internodes smooth, or at least free from stiff hairs. This point had to be looked after carefully so as to allow of good adjustment of the instrument. While the measurements were being made, a registering thermometer was placed near the instrument. The work was done during December and January, 1892–3, and while there were but few sunny days, the plants were under favorable conditions for growth, as the transpiration from the plants would be low, and but slight retardation of growth from light could occur; the temperature also, for the most part, was as high as it would be in the warmer months, the work having been done in a steam-heated greenhouse.

The tomato was measured first, and on Dec. 28th and 29th the record of the second registration showed that the stem was less in diameter than for the first registration, but after that each registration showed the diameter to be greater than at first. In both cases of less diameter, the temperature was very low, which might have occasioned a low tension.

[2]Millardet, A., Nouvelles recherches sur la periodicité de la tension: étude sur les mouvements periodiques et paratoniques de la sensitive, 1870.

A factor of much importance in the growth in diameter is that of temperature, the plant responding within a short period to a rise in temperature by a more rapid growth, and a slower growth following a fall in temperature. The term growth is used, but it is, of course, understood that the increase in diameter includes the tension as well, as the results of the two are not separable.

Taking the line of growth for the tomato for Jan. 1st (plate XIII), it can be seen that the growth bears a close relation to the temperature, the high temperature being followed promptly by an increased growth. The total growth for the thirty hours can be seen very readily in the line plotted.

The same points are seen in the lines of growth constructed from the record of the potato for Jan. 6th (plate XIII). The potato gave a much greater growth, but aside from that the growth took place in the same manner as in the tomato. On these dates occurred the greatest growth obtained from either plant. These two have been selected as typical lines of growth for the two plants measured.

In the lines of growth obtained by taking the average amounts of growth for the different periods, the effect of temperature is not so apparent as there were no regular variations in the temperature, consequently the average line of temperature is not satisfactory in showing the relation between temperature and growth.

Examining the average line of growth for the tomato which was obtained from seven days' records, there are two points of maximum growth, one between 5 and 8 o'clock in the morning, the other between 2 and 5 o'clock in the evening. For the potato the maximum point came earlier in the morning, but was at about the same time in the evening. It was obtained from twelve days' records. The potato under approximately the same conditions gave much the more vigorous growth, but the records for both of them showed clearly that the increase in diameter was really growth, and not an expansion that would be followed by a contraction.

These observations and comparisons show what is possible by the use of the instrument. Further observations are being made in connection with an auxanometer registering growth in length, which was also devised by my brother, and is similar to the one exhibited by Dr. Arthur at the Madison meeting of the A. A. A. S.

Purdue University, La Fayette, Ind.

BRIEFER ARTICLES.

Notes upon the northwestern and Rocky mountain flora. I.—In the summer of 1892 I made a very interesting trip in the northwest. The months of June, July and August were spent in Idaho. My work in that state was done in the sage brush of the southern part, in the Owyhee mountains to the southwest, and in the highlands, foothills and mountains of the central and eastern portions. I traveled by railroad to the principal points, and by stage, carriage or horseback to more distant ones. Of course I walked a good deal. I was well provided with letters of introduction, and there was seldom any difficulty in procuring company whenever desirable, which was necessarily a great part of the time. During the entire season a collection of about eleven hundred species was made, two-thirds of which were from Idaho. Many of these are interesting from the fact that they show new and unexpected localities, and many for showing variations developed under changed conditions. Some plants seem to be quite new. I have learned to regard Idaho as a meeting place of various floras. There one meets with sub-arctic plants from the north which can even be traced to Siberia, and the Cacti and other southern plants are common. There is a large desert flora and also moist thickets and meadows with a most luxuriant vegetation. The Rocky mountain plants meet those of California. In general, I should say that its vegetation is most nearly allied to that of the Pacific slope.

I wish to express my appreciation of the kindness and encouragement I received both from my friends east of the Rockies, and from those I was so fortunate as to make in the state. Had it not been for their efficient assistance I could not have reached many of the distant and less accessible regions which I visited.

Very special thanks are due to Drs. Bessey, Britton, Trelease and Coulter. They not only gave me the best sort of encouragement at the beginning of my trip, but have since extended to me the privileges of their respective herbaria and libraries. My interest and pleasure in the plants have been greatly increased by the very free use I have made of these fine opportunities, which have made my work possible. I subjoin descriptions of a few of the plants from Idaho which I have been recently studying:

Œnothera Idahoensis, n. sp.—Perennial, cespitose, acaulescent or with stout stems 20–50^{mm} long, having young buds developed at base: leaves lanceolate, 12–20^{cm}, decurrent into a petiole, which is usually about one-third of entire length; irregularly cut and incised with sharp jagged teeth usually at right angles to the very prominent midrib; scabrous; lower side clothed sparsely and margins, midribs and petioles very thickly with a long, soft pubescence: calyx tips united, but lobes splitting in bud, and reflexed in flower; tube 10–14^{cm} long, very slender, considerably dilated at throat, lobes 45^{mm} long, narrow; delicate rose color; smooth on inner, hairy on outer surface and on tube: petals somewhat rhomboidal, emarginate, 45–50^{mm} long, 50–60^{mm} wide in dried specimen; white and delicately veined; stamens yellow, versatile, 12–14^{mm} long: capsule ovate, not attenuate or compressed, 30^{mm} long, 10^{mm} broad, very obtusely tetragonal in cross section; not winged but having two thick, tubercular, darker ridges with a depression between them, extending vertically at each angle; corky and hairy, tuberculate: seeds in two rows, angled, not crested, minutely tuberculate.

This belongs to the cespitose group, and I think must unquestionably be called the most beautiful representative of the genus Œnothera. I found it in but one locality and within a limited area. This was on the hills beyond Boisé City, at an elevation of about 3,000^{ft}. June.

Scutellaria Footeana, n. sp.—Perennial, from filiform subterranean stolons, 6–10^{cm} high, much branched, and spreading at base; branches dark, purplish; foliage light green: entire plant including inflorescence, clothed with a minute woolly pubescence: leaves 15–25^{mm} long, entire, oblancelolate to obovate above, cuneate to almost orbicular below; all tapering to a slender petiolate base, and lower ones distinctly petioled: flowers axillary, numerous, 12–18^{mm} long, shorter than the subtending leaves: calyx in fruit a little longer than the peduncle; 6^{mm} long, 5^{mm} broad, nearly orbicular; angle and projection on back much less prominent than in most species: corolla ampliate-dilated at throat, with lower lip much broader than upper, and the two nearly equal in length; lemon yellow to dull brownish yellow at base, deepening to orange color in lobes; somewhat hairy within: nutlets acutely angled, roughly and deeply muricate upon faces and exterior surface; raised upon a much elevated slender gynobase, which appears like a prolongation of the style set upon the posterior side of a thick, scarlet cushion-like disk which bears white nectar glands upon its surface.

I find only two other species described as having their nutlets raised on a slender gynobase. These are *S. nervosa* Pursh of the Middle States, and *S. Guilielmi*, a Japanese species. Both differ from this in having nutlets surrounded by a conspicuous membranaceous wing; hence this cannot be placed in the same section with them according to Gray's definition in the Synoptical Flora.

This was found at an elevation of about 3,500^{ft} near Black Cañon, Boisé River, June 18th. I have named the plant in honor of Mrs. Mary Hallock Foote who planned, and accompanied me upon the pleasant expedition which led to its discovery.

Frasera cærulea, n. sp.—Stems slender, from a branching caudex; glabrous, or nearly so; 15–20^{cm} high, slender: leaves elongated, narrowly oblanceolate, slightly margined; the two or three cauline pairs 4–8^{cm} and the radical ones 10–16^{cm} long; those of the panicle reduced to linear bracts: inflorescence rather closely paniculate; pedicels as long or longer than flowers: sepals narrowly lanceolate with a conspicuous scarious margin: corolla blue; lobes ovate, acute, 6–8^{mm} long, with delicate, forked, spreading venation; glands linear, green; a little below middle, and extending nearly to base; the long villous fringe decurrent into a longitudinally adnate crown, with fringed free margins and saccate, tapering base, which has a longer and coarser fringe: a row of long setae between filaments at base: stamineal scales obovate or nearly orbicular, laciniate; longer than ovary, nearly as broad as lobes of corolla: style slender, twice the length of ovary.

Found, July 9th, on Owyhee Mountains, several miles from the De Lamar silver mine, elevation 7,000^{ft}.

Frasera montana, n. sp.—Stem rather slender, 30–90^{cm} high: leaves opposite, elongated, strongly margined; lowest 15–20^{cm} long, narrowly oblanceolate; upper ones gradually reduced in size, linear: inflorescence paniculate: pedicels two or three times as long as the flowers: sepals narrowly subulate: corolla creamy white; lobes 6–8^{mm} long, nearly twice the length of the sepals, oblong, somewhat acute; bearing the small obovate glands near base; encircling fringe rather short, longer on the decurrent pocket-like base, strongly incurved: scales between bases of filaments very small, deeply cut into two, three or more setous processes.

This species appears to be more abundant than any of the preceding ones. I think I passed it more than once when traveling through the Boisé Basin, and I collected it in two places where it was growing rather plentifully. The fruit was developing on the side of the mountain above Cooper's Warm Springs, at an elevation of about 4,500^{ft}, July 20th, and the flowers were in the height of their beauty on a rocky ledge a few miles from Pioneer, 5,000^{ft} above sea level, July 22d.

The two Fraseras above described seem to form connecting links between the last two divisions of the genus in the Synoptical Flora. Both are long pedicelled, and thus have the loose inflorescence of the former, represented by *F. albomarginata*, to which the species I call F. montana is most nearly allied, and for which it might rather easily be mistaken on a superficial examination. Both show their relationship to the last division by the crown of scales at the base of corolla. This is small in F. montana, and very large in F. cærulea. The form and position of the glands show characteristic differences.

Gilia grandiflora Dougl.—This species is quite common on the foothills around Boisé City. As usually found there it accords very well with the type description. On the higher lands I found so many variations from the type that I could scarcely reconcile myself to classing them together under the one species. The variations are in size, in branching, in character and extent of the pubescence, and in size, number and position of the flower clusters. In all these intergrading forms, there is very little or no variation in the size and form of the light salmon-colored corolla. I describe the most extreme form as

Var. **diffusa**, n. var.—Taller, stems much more slender, 75–100cm high, much branched; branches long below, very short above: leaves linear, shorter, scattered: flowers in much smaller heads, at ends of branches, and summit of stem: glandular and cellular pubescence very thick upon the calyx, bracts, and upper leaves, and sometimes the entire upper portion of plant is pubescent.—A. ISABEL MULFORD, *Herbarium Lake Forest University.*

Frost Plants.—Prof. Lester F. Ward's observations on the "Frost freaks of the dittany," in the GAZETTE for April, 1893, occasioned much interest, since the phenomena illustrate one form of the movement of water in the plant stem. I have elsewhere[1] made a lengthy review of the literature of the frost plants and take occasion to call attention to the following references which may be accessible to the readers of the GAZETTE.

Prof. Ward called my attention to the fact that the frost crystals of *Cunila* and *Helianthemum* were noted by Dr. Darlington.[2] The first observation of frost phenomena recorded is that of Stephen Elliot on the stem of *Conyza bifrons* (now *Pluchea bifrons*).[3] Sir John Herschel noticed a similar formation on the stalks of heliotrope and thistle.[4] Prof. John Leconte made an extended study of the frost crystals of *Pluchea camphorata* and *P. bifrons*, in 1848, along the coast of South Carolina and Georgia.[5] Prillieux in his investigations on freezing in intercellular spaces described the formation of radial ice plates by herbaceous plants.[6] These observations were duplicated by Trecul at the same time, and Sachs has given some matter bearing upon this point.[7] In a recent number of this journal Professor Atkinson gave a note recording the fact that these phenomena were seen by him in 1885–86,[8] while Professor Ward has found that the frost freaks of the dittany are a matter of common information in the locality in which his observations were made.[9]

It seems established that the frost phenomena occur on plants which have ceased growing, or are wholly dead; that the movement of the water upward through the stem and laterally is wholly physical and

[1]Quarterly Bulletin of the University of Minnesota. **2:** 30. 1894. Science **22:** 351. 1893.

[2]Flora Cestrica 350. 1837.

[3]Sketch of the Botany of South Carolina and Georgia. 322. 1824.

[4]London and Edinburgh Phil. Mag. III.—:110. 1833.

[5]Proc. A. A. A. S. 1850.

[6]Compt. rend. **70:** 405. 1870.

[7]Lehrbuch, 2 Aufl. 614.

[8]BOT. GAZ. **19:** 40. 1894.

[9]Science **23:** 66. 1894.

that the frost plants show no especial differentiation of structure, so that it is probable that many plants, if they should pass through the death stage at a season offering the proper conditions of moisture and temperature would furnish "frost phenomena."—D. T. MACDOUGAL, *University of Minnesota.*

Proposed seed collection of the U. S. National Herbarium.—The Department of Agriculture at Washington, D. C., has inaugurated a seed collection in connection with the U. S. National Herbarium which is intended to include seeds of all the species of plants obtainable, especially weeds and forage plants.

The seeds, when not too large, will be placed in flat-bottomed specimen tubes of two sizes, the smaller 5^{cm} long by 1.5^{cm} in diameter, the larger in vials of twice these dimensions. These tubes will be neatly labeled, systematically arranged, and placed in covered trays made of binder's-board. Fleshy fruits of native American plants will be put into similar bottles filled with preserving fluid. Authentic herbarium specimens of plants raised from the seeds represented, or of plants from which the seeds were obtained, will accompany the collection whenever possible.

Seeds of North American weeds, grasses and other forage plants are especially desired and the co-operation of all botanists is earnestly requested. A suitable exchange of seeds for herbarium material or the publications of the Division may be had in return if desired. In the case of weeds and forage plants a liter of seed is wished in order that sets may be prepared for distribution to Agricultural colleges.

In addition to the work above outlined the Division of Botany is about to undertake the testing of various seeds as to their purity and germinative power, for which purpose a laboratory will be fitted up and equipped after the most approved methods of American and European seed-control stations. In this laboratory and in the open air different physiological experiments connected with seed germination and development will be conducted. Histological studies may ultimately be made to determine the structure of the seeds of American weeds and forage plants, and, if possible, to elicit facts of taxonomic value. The entire work will be carried on with special regard to its economic importance, while the collection will be particularly useful for reference.

The matter has been placed in charge of Mr. G. H. Hicks, recently instructor in botany at the Michigan Agricultural College, to whom correspondence may be addressed.—FREDERICK V. COVILLE, *Botanist, U. S. Department of Agriculture.*

CURRENT LITERATURE.

The Letters of Asa Gray.[1]

Most of Dr. Gray's personal friends have known that his letters were being edited by his wife, and they have looked forward, with keen anticipation, to the appearance of the volumes which are before us. Nor will his most ardent lovers (for that phrase alone fitly names those who came to know him intimately) be disappointed in this collection. unless by its unavoidable fragmentariness. In his busier years the letters he wrote were necessarily largely scientific or of purely personal interest, but ithas been Mrs. Gray's endeavor "in collecting and arranging the 'Letters' from Dr. Gray's large correspondence, to show, as far as possible in his own words, his life and his occupation." "Something of the personality of the man and his many interests may be learned from these familiar letters and from even the slight notes."

We can only wish that they might reveal fully his character and personality to those who were never privileged to come under its charm, but if only "something" of it is shown, the thousands who know his name will be interested in gaining these glimpses at the life of a rarely lovable man.

The autobiography which Dr. Gray began, and from which the sketch of his early years published with a portrait in this journal (11: 1. 1887) was chiefly drawn, forms the first chapter. His early undertakings are detailed mostly in letters to Dr. and Mrs. Torrey and his father and mother, with a few to Dr. W. J. Hooker. These give an account of his studies while teaching at Utica and Hamilton college, of his life in New York with the family of Dr. and Mrs. Torrey, which was a potent influence for good, of his relations to the South Sea Exploring Expedition and to Michigan University. The third chapter consists of extracts from a very detailed and intensely interesting journal of his first visit to Europe, where he made many life-long friends. The fresh and vivacious sketches of men and things, the racy comments, the epigrammatic skits hold the attention of the reader and, before his friends, the man lives again. The remainder of the volume tells of his work from 1840–1850.

The second volume is devoted to more general correspondence which is grouped almost by decades under the titles, second journey to Europe, letters to Darwin and others, travel in Europe and America, and final journeys and work.

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[1] Letters of Asa Gray, edited by Jane Loring Gray. 2 vols. crown 8 vo. pp. 838. pl. 6. Boston: Houghton, Mifflin & Co. 1893. $4.00.

It is impossible to make any comment upon these volumes except in words of unstinted praise. The selection of appropriate parts from the enormous mass of letters written by Dr. Gray has been a difficult task, no doubt; but having been done by one who was for almost forty years in loving sympathy with him, it has been accomplished with the utmost good taste, in which it is in marked contrast with some other "Letters" of great men.

Three photo-gravure portraits of Dr. Gray are given, at the ages of 31, 57 and 76. There are also three half-tone engravings, of the botanic garden house in 1852 from a drawing by Isaac Sprague, Dr. Gray in his study in 1879, and the present range of buildings in the botanic garden. Nor must we fail to commend the very copious index, too commonly neglected in such books.

The younger generation of botanists, knowing Dr. Gray chiefly through his floras, have, we fear, come to think of him as a specialist, great in his line of course, but limited in his interest to systematic botany. We, therefore, cannot urge too strongly upon such the reading of these letters, that they may become acquainted with a man not only of commanding ability as a specialist, but of wide interest in other departments and keenest appreciation of them.

Some, we are sure, will be surprised at these words:

"I am lecturing [to his college class] in a popular and general way entirely on physiological botany, and offering no encouragement to any to pursue systematic botany this year. My great point is to make physiological botany appear as it should be,—the principal branch in general education."—p. 325. (1844.)

"I finished lichens this afternoon; and have next two lectures on fungi and spontaneous generation to give. I interweave a good deal of matter, such as, on ferns, the part they played in the early times of the world, à la Brongniart. Mosses filling up lakes and pools; sphagnum, peat. Lichens, first agents in clothing rocks with soil. I have noble illustrations of rust in wheat, ergot, etc., and Sprague is now hard at work on smut, à la Bauer."—p. 330. (1845.)

These volumes will be sure to contribute to a complete understanding of him who deserves better than Robert Brown the salutation, "Botanicorum facile princeps!" For the letters to friends, though written but for the hour, have become abiding because they are a true manifestation of a lovely character whose memory will ever be fragrant.

We adopt the happy phrases of Dr. Sandys, in presenting Dr. Gray for the highest honors of Cambridge University: "This man, who has so long adorned his fair science by his labors and his life, even unto a hoary age, 'bearing,' as our poet says, 'the white blossom of a blameless life,' him, I say, we gladly crown, at least with the flowerets of praise, with this corolla of honor."

Minor Notices.

MR. G. J. PIERCE's interesting studies on the haustoria of some phanerogamous parasites[1] have been distributed in separate form. Mr. Pierce examined the haustoria of *Cuscuta Americana* and found them morphologically lateral roots, originating endogenously and growing only at tip, developing into an organ with bi-collateral vascular bundles united with those of the stem by two strands each of tracheids and sieve tubes. These tracheid and sieve tube strands unite with corresponding parts of the bundles of the host. The haustoria occur usually in groups of not more than the number of vascular bundles in the host; and by the twining of the parasite the successive haustoria unite with different bundles of the host. Other species of Cuscuta were examined with similar results. Having thus found sieve tubes (not previously known) in the haustoria the question arose, do all phanerogamic parasites possess them, and are they thereby able to absorb the newly elaborated material from their hosts? The study of haustoria of *Viscum album*, *Brugmansia Zippelii*, *Rafflesia Patma* and *Balanophora elongata* showed that sieve tubes were absent in the green parasite, Viscum, but present in those which must, because of the absence of chlorophyll, depend wholly on their hosts for nourishment.

THE VERY LARGE private herbarium and library of Capt. John Donnell Smith, consisting of about 80,000 sheets and 1,300 volumes, has been offered to Johns Hopkins University on condition that a suitable building be prepared for their reception and provision be made for their maintenance in connection with a department for instruction and original work in botany. We long since understood that this intention was cherished by Mr. Smith, and we trust that the generous offer will stimulate the University to establish a thoroughly manned and equipped botanical department, to which Mr. Smith's accumulations may be of service. A list of the chief collections comprised in the herbarium and abbreviated titles of the works in the library are published in the J. H. U. *Circulars*, No. 109, Jan. 1894, in order that students (to whom they are already made accessible) may know what is to be found there. We hope that Mr. Smith may long continue his enthusiastic investigations and add greatly to this important herbarium.

THE SEMI-ANNUAL report (Oct. 1893) of Schimmel & Co. (Fritsche Bros.) of Leipzig and New York, who are special distillers and manufacturers of essential oils, is something more than a mere trade pamphlet. A large amount of information, both botanical and chemical,

[1] Annals of Botany **7**: 291–327. *pl. 13–15.* 1893.

is given in the first 67 pages, about various essential oils. This is followed by a table of the essential oils, giving the name of the oil and the part of the plant from which it is obtained, the botanical source, the percentage yield from the raw material, with various physical and chemical observations. The publication would be of interest to botanists generally, we think. It may doubtless be obtained from the New York house on application.

IN THE "Wilder Quarter-Century Book," a collection of original papers dedicated to Professor Burt G. Wilder, at the close of his twenty-fifth year of service in Cornell University, by a number of his old students, appears a paper on the genus Phyllospadix, by Professor W. R. Dudley. This genus of marine Potamogetonaceæ consists of two species growing on our Pacific coast, and is believed by Prof. Dudley to be a comparatively recent offshoot of Zostera. This paper deals "with the morphology, anatomy and environment of the genus in relation to its probable origin."

A FIFTH PAPER preliminary to a monograph of the Laboulbeniaceæ, necessitated by the accumulation of new material, has been published by Dr. Roland Thaxter.[1] Thirteen new species and five new genera are characterized and a synopsis of the 23 genera and 122 species now known is given.

M. HENRY L. DE VILMORIN, whom many American botanists met last summer, has distributed a reprint of an article on the flowers grown in the French Riviera,[2] the beautiful sunny shores of maritime Provence. The article will be of especial interest to lovers of flowers.

MR. B. FINK, of the Upper Iowa University, Fayette, has published a small pamphlet with the title "Blights, Orchids and Ferns at Fayette, Iowa." The first group is presented with key and descriptions; of the others but brief lists are given.

DR. WM. A. SETCHELL has distributed copies of a paper on the classification and geographical distribution of the Laminariaceæ, published in Trans. Conn. Academy 9: 333–375. 1893.

E. M. WILCOX publishes in the Jour. Cin. Soc. Nat. Hist. for July–Oct. 1893. pp. 101–4, a few brief notes on the histology of the stem of *Pontederia cordata.*

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[1] Contrib. from Crypt. Lab. Harvard Univ. XXI. New genera and species of Laboulbeniaceæ, with a synopsis of the known species. Proc. Amer. Acad. **29:** 92–111. 1893.

[2] Jour. Roy. Hort. Soc. **16:** 80–104. 1893.

OPEN LETTERS.

On a new code of nomenclature.

[In a private letter to one of the editors Dr. Kuntze asks that the following extract from it be printed in the BOTANICAL GAZETTE. It was called forth by the editor's explanation that the Madison Congress did not consider itself an international body, and that American botanists were trying to arrange certain rules of nomenclature for their own guidance, which would very likely be given as recommendations to any International Congress considering the subject.—EDS.]

I am surprised to learn from your letter that the American botanists are working out a new code of nomenclature. That will produce a schism between botanists, because the first code, that of Paris, can never be set aside or upset as Americans have partly done already. It can only be amended and augmented, and will be so maintained by conservative botanists in the future. Nomenclature in botany is more a matter of science, ancient customs and justice, than of convenience or convention; but has been treated by recent American botanists (Greene, Britton, etc.) more absolutely or nationally (that is, with no real convention for international science) than (as to their new propositions) with experience, learning and justice. I have already pointed out in my *Revisio Gen. Pl.* 3: [1] that only a few of these propositions are acceptable with the condition for future not retroactive action. Afterwards, in the last meeting of the A. A. A. S., they made more propositions, which were mostly inconsistent, as I wrote you in my last letter. Now you assert in your letter that these inconsistencies of nomenclature are mere recommendations to an international congress, but as these recommendations have been meanwhile applied practically in American check lists, etc., such as the irrational application of the 1753 starting-point of nomenclature before a competent congress agreed to it, these inconsistencies and subversions of the Paris Code are no more recommendations but revolutions against the Paris Code.

The difference between English botanists, who often work against the Paris Code, and American botanists in this matter, seems to me only that the English do it without fixed principles, while the Americans do it partly with revolutionary or wrong principles. If the decisions of national or incompetent congresses are admitted we will never reach harmony in botanical nomenclature. I trust that no competent congress would agree to a new code, and the however obtained affirmation to an aberrant codification (see Genoa), or to a new code of an incompetent congress, would be a kind of humbug. A new code, moreover, would trouble the matter, and would deprive me of my rights as emendator of the Paris Code. I hope the American botanists will avoid a schism, and avoid mistakes similar to those of the Genoa Congress.—DR. OTTO KUNTZE, *Capetown, January 21st.*

NOTES AND NEWS.

M. GASTON BONNIER has been honored with the title "Chevalier de la legion d'honneur."

DR. W. G. FARLOW is publishing in *Garden and Forest* a series of illustrated papers entitled "Notes for Mushroom-eaters."

DR. PAUL SORAUER has retired from the directorship of the Physiological Experiment Station at Proskau, and Dr. R. Aderhold has taken his place.

MR. M. S. BEBB and DR. THOS. MORONG are both in Florida on account of their health; the former at Clearwater Harbor, the latter at Jacksonville.

DR. OTTO KUNTZE has spent the winter in Capetown, "in search of health," as he writes. He intends to go over Capeland, Transvaal to Natal, and return to Germany next May.

MR. C. R. ORCUTT has begun an extensive collecting trip, in which he will be engaged until fall, devoted chiefly to the *Cactaceæ*. He is now in the Colorado Desert, from whence he will go to the Mojave Desert, and then east to Texas and to the City of Mexico.

BULLETIN 37 of the Wisconsin Experiment Station, prepared by Professor E. S. Goff, gives a very full account of the Russian thistle, with a fine illustration, among others, of a plant three feet in diameter found by Mr. L. S. Cheney, growing within a mile of the city of Madison.

J. K. HASSKARL, once joint director of the botanic garden at Buitenzorg, Java, distinguished through his introduction of the Cinchona culture there, died at Cleve on the 5th of January in moderate circumstances although he had provided his native country with a yearly revenue reckoned by millions.—*Münch. allg. Zeitung.*

AT THE MEETING of the Botanical Society of Munich on January eighth Dr. F. Brand described and illustrated by herbarium specimens the forms of the leaves of Nymphæaceæ. He finds three sorts readily distinguishable. These are the submersed leaves, the floating leaves and the aerial leaves. These are not only structurally but functionally different.

PROF. L. H. PAMMEL is the author of the following articles published in the Transactions of the Iowa Horticultural Society for 1892, recently distributed: Climate and its effects on the quality of apples. Crossing of cucurbits, Fruit rots and their prevention, Fungous diseases of the grape. The volume includes the proceedings of the Iowa Academy of Science for 1892 (113 pp.), also containing papers by Prof. Pammel.

IN *Le Botaniste* (Jan. 15), the editor, M. Dangeard, presents a paper, illustrated by four plates, on the sexual reproduction of fungi; in which the general question of sexual reproduction in algæ and fungi is first considered, followed by an account of the results of investigation into the structure of Ustilagineæ. As to the systematic position of Ustilagineæ the author thinks that they, with the Uredineæ, form a transition group, leading from the Phycomycetes on the one hand to Basidiomycetes and Ascomycetes on the other. To this transition group the name Mesomycetes is given, already suggested by Frank.

In the *Kew Bulletin* for January the Herbarium begins the publication of a series of novelties from tropical Africa. But three volumes of Oliver's "Flora of Tropical Africa" (1868–1877) have appeared, and there has been but little time to prosecute the work further, the whole staff having been employed in determining the rapidly increasing collections and in assisting Sir Joseph Hooker in his "Flora of British India," now approaching completion. Now, however, the "Flora of Tropical Africa" is to be pushed to completion, but in order to secure priority for names the present series of descriptions of new species are to be published in the *Kew Bulletin*. This first fascicle contains twenty-two species of Apocynaceæ, by O. Stapf; ten Gentianeæ, twenty-two Boragineæ, and ten Bignoniaceæ, by J. G. Baker.

In the March number of *Harper's Monthly Magazine* there is an admirable article by W. Hamilton Gibson on "the welcomes of the flowers" to insect visitors, illustrated by many of his unrivaled sketches. Even into his diagrams he puts an artistic feeling which almost makes them pictures, while his drawings are, as every one knows, simply inimitable. After sketching the history of the knowledge of the pollination he describes charmingly, with almost no technicality, the modes of insect pollination in Salvia officinalis, Kalmia latifolia, Andromeda ligustrina, Iris versicolor, Collinsonia Canadensis, Rudbeckia hirta, Arum maculatum (after Müller) and Pogonia ophioglossoides. We predict that some of these illustrations will become classics, and doubt not copies will adorn many a chart and text-book. May their tribe increase!

Dr. Arnold Dodel-Port has begun the publication through Cæsar Schmidt, of Zürich, of a new set of wall charts entitled *Der biologische Atlas der Botanik*. Those who possess the earlier set (published between 1878 and 1883 under the title, *Anatomisch-physiologischen Atlas der Botanik*) and who know its excellences will be minded to order the new work. The sheets of the present atlas are twice the size of of the preceding, viz.: 84×120^{cm}, which will be a decided improvement. High schools and academies which do not desire the sheets dealing with the more recondite matters can purchase what they can use. For example in the first series of seven sheets, dealing with Iris sibirica, the first four, on (1) bees and flowers, (2) color and the secretion of honey, (3) structure and development of the organs of fructification, (4) structure and contents of the ripe fruit and seed, can be ordered, and the remaining three, on (5) developmental history of the ovule, (6) the processes of fertilization, (7) germination of the seed, can be left out. We are glad to commend this work and hope for it a wide sale in this country. The price is very reasonable, viz.: M. 40 for the first series of seven sheets.

DURAND on MYXOMYCETES

DURAND on MYXOMYCETES.

DAVIS on CRYPTOGLENA AMERICANA, n. sp.

GOLDEN on AUXANOMETER.

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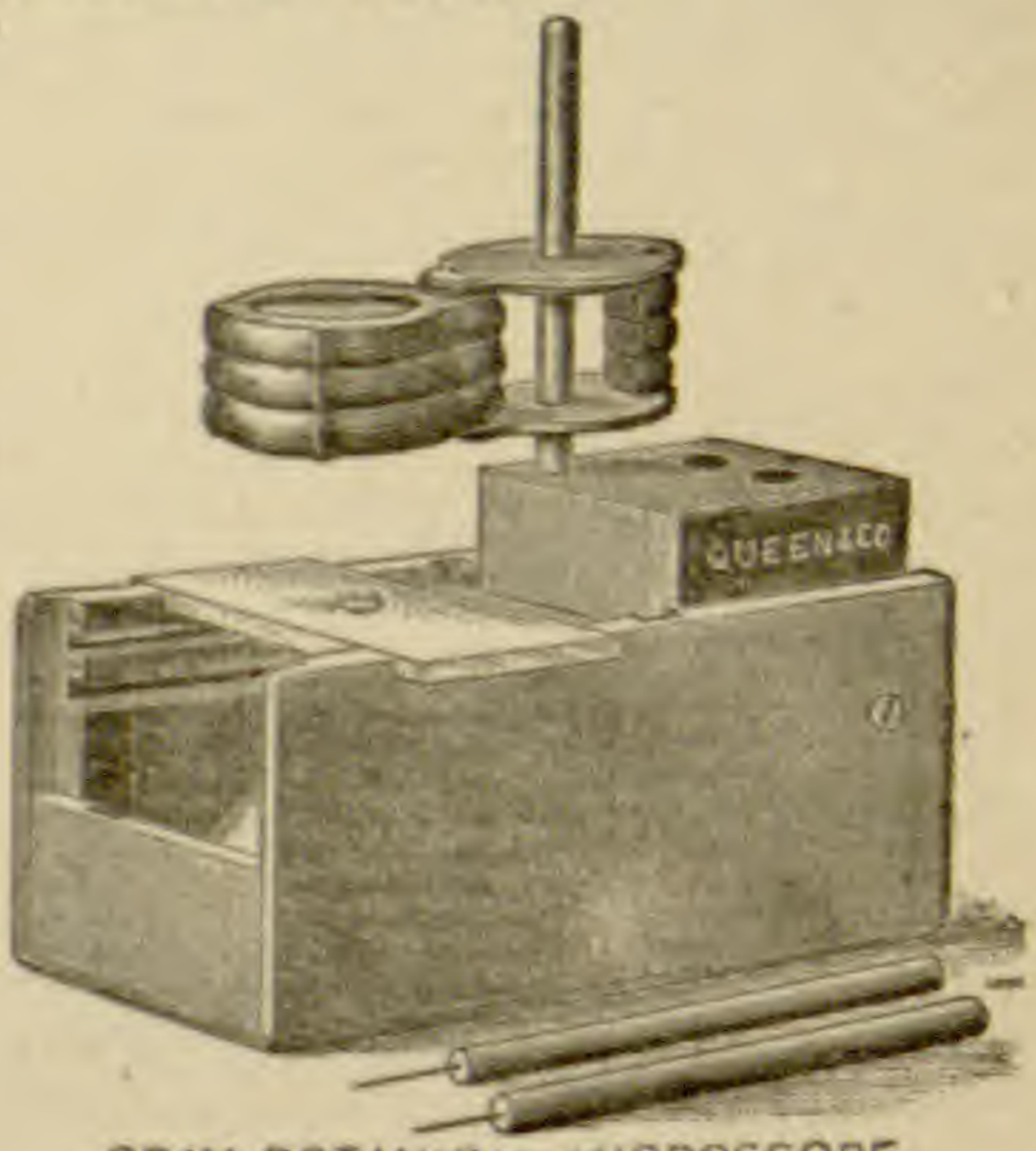

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Missing Numbers.—Will be replaced *free* only when claim is made within 30 days after receipt of the number following.

[Entered at the Post-office at Madison, Wis., as second-class postal matter.]

In the May number will appear:

A study of Quercus Leana, by REV. E. J. HILL, *Englewood, Chicago.*

Contributions to the life history of the Pontederiaceæ, by EDGAR W. OLIVE, *Wabash College, Crawfordsville, Ind.*

Notes on Ustilagineæ, by DR. WILLIAM A. SETCHELL, *Connecticut Agric. Exp. Sta., New Haven.*

The influence of mechanical resistance on the development and life period of cells *will be concluded in the June number.*

BOTANICAL GAZETTE

APRIL, 1894.

Artificial cultures of an entomogenous fungus.

GEO. F. ATKINSON.

WITH PLATES XIV—XVI.

While making collections in a ravine near Ithaca, N. Y., known as Coy glen, on October 28th, 1893, a specimen of *Isaria farinosa* (Dicks.) Fr. was found upon an arctid chrysalis nestling in the leaf mold, the sporophores of the fungus just projecting above the loose leaves. This plant usually consists of several sporophores, 1–2^{mm} in diameter and 2–4^{cm} in height, issuing from the host. The slender portion of the sporophores, constituting two-thirds to three-fourths of their length, is from whitish to pale yellow or orange yellow in color; while the clavate portion, upon which the fructification is borne, is 2–4^{mm} in diameter, white in color and farinaceous in texture upon the surface. A section of the clavula shows that the interior consists of a mass of hyphæ in arrangement and color similar to those of the sterile portion of the sporophore, being composed of very slender threads lying close together in irregular parallel series. Toward the outer portion of the clavula the threads which arise as branches from the central bundle are whitish and very loosely arranged, forming a fluffy mass. The threads of this fluffy portion branch profusely in a monopodial fashion at first. The terminal branches, very short usually, arise either singly, or opposite, or in whorls. Upon the ends of these final branches the lanceolate basidia are borne in pairs or groups of a varying number. The basidia are surmounted by slender sterigmata which produce the spores in chains much in the same fashion as they are borne in species of *Penicillium*. Indeed the spore clusters when separated resemble very closely the fructification of some species of this genus. The spores are short elliptical or usually rounded, and measure about 2μ.

Upon reaching the laboratory with the material an attempt was made to cultivate the fungus in ordinary culture media. Accordingly dilution cultures were started in the usual way for the separation of the organism in agar-agar peptone broth, the three dilutions made in culture tubes being poured into Petrie dishes. The cultures were started at about 5 P. M. on the same day as the collection was made, Oct. 28th. On the following morning an examination was made at 10 A. M. No spores were seen which had germinated, though a very thorough search was not made. Oct. 30th, at 9:30 A. M. a second examination was made. Numerous spores had germinated and growth was progressing finely. One or two germ tubes issue from a single spore, and their points of origin, when there is more than one, may be on opposite sides of the spore or on the same side. The general course of the threads at first, when branching does not occur, is quite straight, but the outline of the thread is variously sinuous. Septa probably occur at this stage but they could not be observed while examining the culture in the agar. The protoplasm is very finely granular, and appears to be massed together in certain parts of the thread and spore, the other spaces being occupied with a homogeneous or watery substance. The study of the stages of germination was made from culture no. 1 by placing the Petrie dish upon the stage of the microscope. The spores on the sporophores of the fungus were so numerous and the material was in such a fresh condition that very few foreign organisms appeared in dilutions 1 and 2, while dilution no. 3 was pure, and the separation was effected without any difficulty. From this separation pure cultures were started by transplanting the fungus to culture tubes of ordinary agar, bean stems, and potato. In fact pure cultures were also obtained by touching a flamed platinum needle to the spores on the clavula of the sporophore and then thrusting it into nutrient agar. But the separation was considered necessary in order to have proof in the case of such small germs that the growth obtained was that of the desired plant by watching the germination of the spores and the development of the colonies from these isolated centers in the dilutions.

The fungus grows quite rapidly on artificial media in the culture tubes, soon forming on the surface of the medium a dense velvety growth with quite a long pile. On oblique slices of potato the larger part of which is exposed, partly dry and not in close contact with the sides of the tube, the fungus spreads quickly, and extends more slowly through the substance of the potato to the surface which is in closer contact with the culture tube, and which is quite moist from the excess of water on the bottom and the side of the tube to which it gravitates as the tube is kept in an oblique position. As the watery infusion gradually disappears by slow evaporation and by being absorbed by the growth of the fungus, the threads appear on the other side of the potato. Now since there is a less content of water and the substance has lost some of its richness, the fungus does not grow so profusely nor so rapidly. There is then a tendency to grow into sporophores composed of numerous parallel threads which arise from the surface of the substratum in the same manner as the normal sporophores of the Isaria stage on the natural host, the pupa of the insect. The large majority of these sporophores on potato are much shorter than those on the insect, but they are also much stouter, the diameter being two to four times that of the sterile portion of the sporophore as it appears in nature. From ten to forty of these sporophores may arise from an ordinary sized piece of potato in a culture tube and they are of an orange buff, or buff yellow color. Many of these are from $2–4^{mm}$ high, while still others are $6–10^{mm}$, and they may be divided at the free extremity into several portions. In one culture a very large sporophore was developed which became at length fully 3^{cm} long. It arose perpendicular to the surface of the potato and thus nearly perpendicular to the side of the tube so that when it was 6^{mm} long it came squarely against the wall of the tube. Here the end remained fixed and it appeared for a time as though the sporophore would not grow any longer. From the outer surface of the end which was in close contact with the wall numerous fine radiating threads of the fungus grew out over the inner side of the tube for quite a distance. At the base of this growth the surface presented the farinaceous appearance characteristic of the fructification. In the course of a week it was observed that the sporophore had continued to grow in length and was turned to one side so that its course was downward in the tube. This continued until the entire length of the sporophore was 3^{cm}. At various places it appeared to halt and send out a thin membranous expanded growth, closely attached to the side of the tube, showing the color of the sterile portion next the wall of the tube, and, on the opposite side, possessing the farinaceous appearance of the fruit. Eventually from several of these expanded portions of the sporophore elongated, radiating, branched, terete fruiting portions were developed, which altogether formed quite a complicated condition of this phase of the plant.

Probably the reason that so many of the sporophores on the potato were very short was due to the fact that the moisture almost entirely disappeared before they were perfected. In every case, however, the free ends of these sporophores were covered with the characteristic fructification.

While no characteristic sporophores are developed at first when there is a large water content and the profuse growth of the fungus forms a long pile covering the substratum, yet spores are developed in great numbers. From these spores on a potato culture pure dilution cultures were started in nutrient agar, in order to study carefully the characteristics of growth and the appearance of the colonies in the artificial medium, as well as the peculiarities of the fructification formed when the sporophores are absent. Dilution cultures were made in order to have the colonies properly separated in the plate. Three dilutions were effected December 28th, at 5:30 P. M., and were poured in Petrie dishes. From no. 1 the study of germination and the development of the colonies was made. December 29th, at 12:30 P. M., the culture was examined. Only a few of the spores were germinating at this time. Those which were immersed in the agar were hyaline in appearance. A few spores here and there were not wholly immersed in the medium, probably owing to the fact that they were dry when the dilutions were made and did not absorb sufficient moisture to permit all of them to sink readily in the liquid. These spores appeared quite dark, as if the wall was dark in color, which resulted from the strong refraction of the light. When these superficial spores germinated, the germ tube penetrated the medium and was hyaline in appearance. Prior to germination the spores swell considerably so that the diameter of the spore is nearly twice what it is when the spores are matured or before they are placed under conditions favorable to germination. Those measured showed a diameter of 3–3.5μ. The germ tubes were little more than 2μ in diameter.

On December 30th the culture was examined again. Many spores had by this time germinated, one to two or three tubes having arisen from a single spore. Branching also by this time was taking place quite freely. Rather faint vacuoles appear in the thread at quite regular intervals as if in the middle of the cell, the transverse walls of which are hard to distinguish in the agar. By December 31st the growth had increased sensibly and the branching was becoming quite profuse while some of the shorter branches were being elevated in the air, but there was as yet no evidence of spore formation.

When the colonies become perceptible to the unaided eye the surface ones are circular, quite compact, and with very fine numerous radiating lines on the margin, giving it a finely fimbriated appearance. When young the deep seated colonies are apt to be angular so that many of them are triangular in form. As the colonies age the superficial ones, or those which reach the surface by later growth, become convex by the elevation of numerous threads which give it a whitish fluffy appearance at the center, while at the margins it is still finely fimbriate from the radiating threads. While the colonies are quite young they resemble those of a species of *Penicillium*, probably *P. glaucum*, which appeared accidentally in culture no. 3. In plate XIV, figs. 2, 3, 4, this single colony of Penicillium can be easily differentiated from the colonies of Isaria, but in fig. 1 it is impossible to do so except by selecting the corresponding location of the colony in the plate, all the four photographs of the cultures being from the same dish at successive stages of growth. When the Penicillium colony fruits the sporophores are quite long and erect and are so arranged that open spaces appear here and there through which the light passes more easily than at other places and a strong differentiation between light and shade appears over different parts of the fruiting portion of the colony. There is also very little of the fluffy arrangement of the aerial hyphæ, such as occurs in the Isaria colonies.

As the colonies of Isaria become more and more elevated from the medium they become mealy white in appearance from the numbers of spores produced, mixed with the mass of cottony threads. The appearance of the colonies may be varied somewhat by periodic growth, induced by variations in the temperature. Some tests of this were made with the culture no. 3 of the dilution for the separation of the fungus.

After growing for some time in a rather cool room, at a temperature ranging from 15–18°C., the culture was placed in the thermostat with a temperature of 25.6°C. In a few days a profuse growth had taken place, making a distinct concentric ring. At the center was a strongly convex dense portion, separated from an outer ring which was elevated above the intervening portion. In the thermostat at the higher temperature this ring frequently became elevated considerably above the center of the colony. The margin of the colony presented a larger corona of radiating threads than would have appeared had the culture been kept at the lower temperature for the same time.

By January 12th the colonies from the pure culture started Dec. 28th, examined with a low power of the microscope, show the loose cottony mass to be composed of numerous interwoven threads bearing short sporophores consisting of a single thread. Usually these were arranged in a monopodial fashion but sometimes they were opposite. These correspond to the ultimate branches of the external layer of the clavula on the natural sporophores. Like them they are surmounted by several short lanceolate basidia, the sterigmata of which bear long chains of spores, reminding one very forcibly of the fructification of a *Penicillium*, though on shorter sporophores.

The illustrations in plate XIV are natural size reproductions of culture no. 3 at different stages of growth. In figs. 1 and 2, the colonies were not yet elevated above the medium, and, being transparent and very delicate, could not be photographed by reflected light to show the peculiar characters. In figs. 3 and 4, the colonies were elevated at the center above the medium. Figure 3 was photographed by transmitted light to show the finely fimbriated margin of the colonies and the relation of the same to the denser portion of the colony. This photograph is not as good as it should be under favorable circumstances, since by this time the medium had become milky in color from the entrance of some species of bacteria which had accidentally gotten into the culture, a small colony of which can be seen on the upper right margin. The light transmitted through the milky portion of the medium also affected the sensitive plate and the differentiation between the colonies and the intervening spaces was not strong. It is sufficiently so, however, to show the character of the margin of the colonies. By transmitted light the elevation of the colonies could not be shown. This can be done by photographing in the ordinary way by reflected light. Such a photograph taken on the same day is reproduced in figure 4, of the same plate. The margin of the colonies, however, is not shown by this process, but a knowledge of the true character of the colonies can be obtained by putting the two photographs together.

Several cultures on artificial media in culture tubes have been made but in no case has any thing resulted which shows the perfect or ascigerous stage of the fungus. Upon nutrient agar, nutrient gelatine, and bean stems, nothing but the cottony or fluffy growth, covered by the farinaceous fructification, appears. On potato this growth first appears, to be succeeded by the characteristic fructification of the Isaria stage.

Tulasne has shown[1], not by cultural experiments, but by contiguity of development, that *Isaria farinosa* (Dicks.) Fr. is the conidial stage of *Cordyceps militaris* (Linn.) Link. A large number of cultures, perhaps varying the substratum and other conditions of environment, might result in the development of the Cordyceps form in artificial cultures from the Isaria stage.

The fact that the Isaria stage will develop readily on various media such as described above is evidence that it can develop readily as a saprophyte, and is thus more likely to be preserved in greater abundance and in wider distribution than if it were able to propagate itself only on insects.

Botanical Department, Cornell University.

EXPLANATION OF PLATES XIV–XVI.

PLATE XIV.—Fig. 1. Photograph, nat. size, by transmitted light, of plate culture in agar, showing colonies.—Fig. 2, same at more advanced stages of growth.—Fig. 3, same at still more advanced stage showing the fimbriated margin of colonies.—Fig. 4, same by direct light to show elevation of colonies.

PLATE XV.—Fig. 5, germinating spores.—Fig. 6, farther advanced stage.—Fig. 7, group of fruiting basidia from sporophore of plant developed under natural conditions.—Figs. 8 and 9, same, from culture on agar.

PLATE XVI.—Fig. 10. Photograph of Isaria farinosa from which cultures were started; magnified twice.—Fig. 11, fructification in elevated portion of colony on agar.

In plates XV and XVI the scale shown is 1 mm magnified about 18 times. Figs. 5, 6, 7, 8, 9, 11 are magnified 50 times more than the scale. Drawn by aid of camera lucida.

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[1] Note sur les Isaria et Sphæria entomogenes. Ann. d. Sci. Nat. Bot. IV. 8: 35. 1857.—Torrubia militaris. Selecta Fung. Carp. **3:** 6. 1865.

On the absorption of water by the green parts of plants.

W. F. GANONG.

Notwithstanding many experiments, the question as to whether land plants absorb any considerable quantities of water through their green parts is still unsettled. It is to be noticed that the two extremes of absorption, i. e., the absorption of the major part of the water supply on the one hand, and of extremely minute and physiologically unimportant portions on the other, are here not brought into discussion. The first is settled beyond all doubt in the negative, and the second is of comparatively little importance and appears to be beyond any of the methods of investigation yet applied to it. But to know whether plants can under any normal conditions absorb water through green parts to an extent sufficient to profitably supplement the root supply, is of much general interest, even though, as a side question upon which nothing of consequence depends, it is of no great scientific moment.

The belief in the affirmative of the problem is very old and wide-spread, perhaps indeed nearly universal among gardeners and others dealing in a practical way with living plants. Its principal basis is the familiar fact that plants drooping through loss of water by too rapid transpiration revive if sprayed in the ordinary fashion. But if the conditions of this spraying be controlled and varied by experiment, the relationship of cause and effect is found to be quite different from that which is apparent. If (as has incidentally happened in some of the experiments presently to be described) the water be kept from the roots and the damp atmosphere created by the spray be soon removed, the plant does not revive. Or if the damp atmosphere be retained and the plant revives, its weight is found not to have increased, but rather diminished, as the following shows:

Exp. a. Healthy young *Ricinus*, the pot and earth wrapped in rubber cloth, was kept in a dry window one day until it was drooping for want of water. Then weighed 372 gm. Placed in bell-jar moistened within, in twenty-four hours it had completely revived, but weighed 369.430 gm.

Or again, if a plant be used which has wilted not through too rapid transpiration, but through slower loss of water so that the soil has become dry, and if the soil be protected, it will not revive at all when sprayed and kept in a damp atmosphere. The explanation of these facts seems to be that the rate of supply of water to leaves by conduction from roots has a maximum which may be exceeded under the same conditions by the rate of loss through transpiration, and when this occurs drooping follows. To plants in this condition spraying, when it does not directly water the earth, creates a moist atmosphere which is for some time maintained by evaporation of the clinging water-drops; transpiration is thereby diminished until it is equalled and exceeded by conduction, and revival follows. But when the drooping is the result of absence of water at the roots, these being protected no revival can follow the spraying except by direct absorption through the green parts; and the fact that in such cases no revival takes place is fair evidence that absorption through the green parts cannot, to any appreciably profitable extent, occur. That the revival of drooping parts can and does follow simple diminution of too rapid transpiration without addition of water, is shown upon a large scale out of doors in gardens when hot summer days are followed by cool evenings, and still better, in the irrigated regions of the west, in both of which cases there is an evening revival of parts which drooped under the heat and brightness of the day.

So much for the popular notion. In scientific circles there has been less unanimity. The earliest experiments of importance were those of Duchartre (1861),[1] who, starting with the idea that plants absorb dew through their leaves and wishing to measure its amount, was led by his experiments to conclude that practically they do not absorb dew or mist. His trials were mainly with entire plants, and carefully made. In 1878 Boussingault published[2] the results of his studies, which were largely upon cut plants, concluding that absorption does take place through green parts. In the meantime Henslow had been carrying on independently similar studies with similar but even more positive conclusions, and these were published shortly after.[3] Sachs in his "Lectures on the Physiology of Plants"[4] gives his opinion that the "numerous

[1] Bull. Soc. Bot. de France, **4**:—.—.
[2] Ann. de Chimie et de Physique. March, 1878.
[3] Journ. Linn. Soc. (Bot.) **17**:313–327. 1879.
[4] Engl. Ed. p. 254.

researches directed to this end [i. e., absorption through leaves] have yielded no satisfactory results whatever," and that it is not proven "that any considerable quantities of water, and salts dissolved in it, are conveyed by means of the leaves of the land plants, and that the activity of the roots and of transpiration is supplemented by this means." Vines in his "Lectures"[5] devotes a couple of pages to the subject and concludes that while under special conditions such absorption may take place, "the evidence before us is insufficient to prove that the absorption of water is an important normal function of leaves." Nothing further of importance appears to have been published of late.[6]

The paper by Henslow above cited as being the latest and most positive and as well the basis of the tests to be presently described, requires some analysis here. In reviewing the work of Duchartre, he contends that the phenomena shown by a cut shoot are a safe guide to the phenomena shown by the entire plant. But it is best to quote his exact words,[7] which are these: "It is easy to prove that all the functions of a leaf *are* carried on when detached as when growing;" and again, "all that can be called injurious to a shoot when detached for experimental purposes lasting for a short time only, is that the supply of water is cut off. The shoot may become flaccid and slightly enfeebled, but in no sense are its functions impaired. And I maintain, making due allowance for that fact, whatever results a cut shoot or detached leaf gives in the matter of absorption and transpiration, they *are* [sic] legitimately applicable to a growing plant. Those who assert it to be otherwise must bear the burden of proof."[8] It is not surprising after these statements, that this writer considers the results of his many experiments upon cut shoots as applicable to normally growing plants, and that he therefore con-

[5]Pp. 65-67.

[6]In Science, July, 29, 1893, Mr. E. A. Burt publishes some notes which show that cut shoots absorb some water. He also thinks that some absorption takes place in uninjured plants at night, but his experiments do not seem conclusive on this point.

[7]Op. cit. pp. 314, 315.

[8]According to this contention, if a cut shoot could be supplied with a water supply equivalent to that which it has before cutting, it could continue to act normally in its water relationships for an indefinite period. Mere dipping in water is of course not enough, as root pressure is absent. But I have attached tubes to the cut petioles of leaves, giving them a pressure of a column of three to four feet of water, and they remain fresh but little longer than those merely placed with the cut ends in water.

cludes: "There are ample reasons for believing that dew and rain are under certain circumstances absorbed and utilized to supplement the root supply."

Whatever may be thought of the relationship of Henslow's experiments to his conclusion, this much seems to be clearly shown by the former, that cut shoots do absorb water through their green parts. Many of his experiments have been repeated with results similar to his.[9] But when very similar methods have been applied to uninjured shoots attached to their parent plants, the results (I may so far anticipate as to say) have been different; from which, together with other considerations, it seems that there is a marked *qualitative* difference between the behavior of injured and uninjured plants and parts of plants with reference to their power of absorption of water through their green parts, and that no conclusions can be safely drawn from results in the one case, as to the conditions in the other.

In order to test Henslow's conclusions, and to contribute to the settlement of this problem, I have carried out a rather elaborate series of experiments; and although the results are not so complete and positive as was hoped, they nevertheless have value in this direction.

In experimenting upon entire plants some method of preventing access of water to roots and soil is necessary. This can be conveniently done by use of dentists' rubber cloth; a comparatively small hole therein can be stretched so as to pass over the entire pot and yet shrink so as to clasp the stem above, where it can be further secured by winding with waxed thread. The folds of the rubber may then be gathered beneath the pot and tied. The result can be a water-tight isolation of the entire pot and contents, which is not necessarily injurious to the plant,[10] and this was the method used in the following experiments. Often to prevent access of water to soil in spraying, etc., the plant was laid and kept on its side. When it was needful to keep up a con-

[9] As also by Mr. Burt in the paper mentioned in foot note 6.

[10] Plants thus kept for weeks or even months have been healthy and clean at the end. On the other hand, there sometimes appeared a sudden and very marked "rubber disease." At the contact of rubber and stem, the latter would turn dark, shrink greatly and become dry. I could find no constancy in its appearance. It is worth study. All such plants were of course at once rejected. Late in the course of experiments, it was found that the rubber allows water vapor to pass through it especially when stretched, but it is believed that any error from this source cannot be great enough to materially affect the accuracy of the results.

stant supply of water both day and night to wet surfaces, it was done by connecting them by means of short ribbons of filter paper with beakers kept filled with water. All cases of comparative wetting, etc., were judged by other and disinterested persons. In all weighings allowance was made for withered leaves, etc. Some of the experiments were conducted in large Wardian cases, others in bell jars. When it was needful to keep the air in the latter saturated, it was done by use of wet sponges as well as by shallow dishes of water. Those experiments which are described below are the best from a very large number. There were a few cases in which contrary results were obtained, but in all such, some error could have (or was known to have) come in.

For convenience, the experiments were divided into four divisions:

1. Absorption from wet surfaces.
2. Absorption of water supplied in drops, as rain.
3. Absorption from a quantity of liquid water.
4. Absorption of water-vapor.

1. Do uninjured plants through their green parts absorb water from wet surfaces?

Exp. b. Strong plant of *Senecio petasites*; herbaceous, broad-leaved, 2ft high, branching just above base into two nearly equal stalks. Of one stalk about half its length was wrapped with filter paper kept constantly wet. In open air of room. Second day, traces of drooping in unwrapped stem; third day, leaves drooping on both stems, slightly less on wrapped stem; fifth day, leaves much wilted on both, no discernible difference; sixth day, greatly wilted; tenth day, all leaves dry and withered and stems drooping; a disinterested person could not tell which was most wilted.

Exp. c. Three strong plants of same species of Senecio all 20–24in high, in two pots previously treated alike; in the one, two plants, one single stalked, other three-stalked from near the base, in other pot single stalked plant. All three stalks of three-stalked plant were closely wrapped throughout, including even the leaf-axils, with filter paper constantly kept wet. In open air of room. Second day, no change; third day leaves showing signs of drooping in all three plants; fifth day, leaves drooping equally on all stalks; seventh day leaves all drooping and nearly equally, if any difference, somewhat less in wrapped stem; all continued to wilt and stems to droop until all were dead and no marked difference between them.

Exp. d. Two plants of *Hura crepitans* in separate pots, previously treated alike; stem of one wrapped completely with filter paper, kept wet. Other unwrapped, placed under large bell jars open at top; first day, no change, both vigorous; fifth day, lower pair of leaves drooped to wilting in each case; eighth day, leaves wilting on both, but no difference between them; tenth day, both wilting, but no marked difference, if any the wrapped stem rather more drooped; both continued to wilt until dead, but neither more rapidly than the other.

Exp. e. Three plants of *Coleus* sp?; common little-colored variety: 1 with three long internodes wrapped in filter paper kept wet; 2, unwrapped; 3, five *leaves* out of its twelve had filter paper pressed against both surfaces and kept wet. Placed in large Wardian case: third day, all drooping both leaves and stem, but less in no. 3; tenth day, no perceptible difference between 1 and 2, but from no. 3 leaves have dropped, though stem in better condition than in 1 and 2. Continued until all dead, with no marked difference between 1 and 2.

In all of the above cases, and in others not here described, the wrapped plants acted precisely as if the wet paper were not present; in other words they showed no signs of ability to "supplement their root supply" from this source. How very different is their behavior in comparison with that of Henslow's cut shoots exposed to very similar conditions!

2. Do uninjured plants through their green parts absorb water supplied to them in drops by spraying (or rain)?

Exp. f. A *Coleus* 8^{in} high, allowed to dry slowly in Wardian case until drooping, i. e., through partial exhaustion of root supply; wrapped in rubber, wt. 158.310^{gm}; laid on side and sprayed with water for several minutes, completely drenched; watched for two hours; it had dried and weighed 158.220^{gm}, and had not revived in the slightest.

Exp. g. Young *Pelargonium* dried slowly in Wardian case until leaves drooped; wrapped in rubber and laid on side and thoroughly drenched with spray; during and after drying it did not revive in the slightest.

Exp. h. Very fine young *Begonia* in small pot, with many leaves and splendid development of trichomes; wrapped in rubber, wt. 206.915^{gm}; sprayed 5 min. with distilled water until drenched; left not in sunlight for 24 hours in Wardian case, wt. 204.815^{gm}; again heavily sprayed as before; in two hours dry or nearly so, wt. 204.675^{gm}; then placed in a saturated bell jar for three days, wt. 203.005^{gm}.

Exp. i. Healthy young *Begonia;* wrapped in rubber, and kept in Wardian case until it drooped slightly, wt. 179.090^{gm}; sprayed thoroughly and at once put in a wet bell jar; next day, wt. 179.070^{gm}: four days later, 178.250^{gm} and no revival of the drooping leaves.

Exps. various. Other *Begonia*, *Coleus* and *Hura* plants, allowed to dry slowly until drooping, then sprayed until dripping with water and allowed to dry, when water was kept from the roots, always failed to revive, and when weighed always showed a loss.

It is of course true, that in any or all of these cases, very small quantities of water may have been absorbed. But it seems plain that no quantity of physiological importance could be taken by the plants from that so abundantly supplied to them. The evidence of the weights shown by the balance is of course of minor value, as transpiration might lessen the weight more than the absorbed water (if any) could increase it; but where transpiration in a thirsting plant is reduced to a minimum in a wet jar and a loss of weight follows, it seems to be certain that no absorption sufficient to be of use to the plant can occur.

3. Do uninjured plants, through their green parts, absorb from a quantity of liquid (hydrostatic) water?

Exp. j. Vigorous young *Helianthus*, 14in high, was allowed to droop for want of water until it bent over to the table. Its top, containing four young leaves and the bud, was allowed to dip into a basin of water, leaving two lower leaves in the air. It showed no trace of improvement and soon died.

Exp. k. Two vigorous *Helianthus* plants, each about 18in high, allowed to droop for want of water until they bent over in a curve to the table. The two large lower leaves of each were then placed in a basin of water while the tops with their leaves were left outside. Whole placed in Wardian case where transpiration could not be too rapid. Both plants continued to wilt until dead, the leaves in water turning yellow and soon dying also.

Exp. l. Young *Begonia* with two strong leaves, one placed in basin of water, one not; whole placed under a bell jar open at top; plant continued to wilt until it died.

On this division of the subject, the experiments are too few and inconclusive, but this is perhaps of the less importance, since such absorption could have very little opportunity to occur normally in nature. Henslow found that an uninjured plant of *Mimulus moschatus* lived for months after one of its shoots had been immersed in water, but this was plainly by virtue of the adventitious roots which it put forth.

4. Do uninjured plants, through their green parts, absorb water vapor?

Exp. m. Strong young *Pelargonium*, wrapped in rubber cloth, weighed complete 187.104gm; dried rapidly by current of air dried by $CaCl_2$ until in two days it weighed 181.186gm; then in Wardian case three days, wt. 180.135gm; then in wet chamber, nearly saturated; in one day wt. 179.552gm; in three days, 178.732gm; four days, 178.212gm; seven days, 176.830gm; and many new leaves appearing[11]; nine days, 175.920gm; continued to decrease steadily in weight for two months until it died.

Exp. n. Young but well-rooted *Coleus*, wrapped in rubber cloth, weighed 182.645gm; dried in open bell jar for four days, weighed 181.802gm, drooping; placed in saturated bell jar; after one day, wt. 181.376gm; two days, 180.744gm; continued to lose weight, dropping old leaves and putting out new ones until it died.

Exp. o. Strong young *Coleus*, wrapped in rubber, all old leaves removed, plant left in Wardian case several days to recover; put out new leaves; then put in a saturated jar and it lost weight until it died. Young *Pelargonium* acted similarly.

Exp. various. Several plants died for want of water in an atmosphere saturated with it.

These latter experiments prove nothing new, but they have their value in this connection as showing forcibly that a plant may die for want of water in an atmosphere saturated with it. If the absorption of water vapor were an "important normal function of leaves" this ought not to be so rapid and positive as it is.

[11]This was several times noticed, and is referred to by Henslow, who thinks that young leaves are a medium of absorption, and are hence put out in greater numbers when water from the air is needed. It is also worth remark that some evidence was observed indicating that when a leaf attached to its plant is injured, it may absorb water through the injury.

Of the whole subject, in summary, it may be said, that while these described experiments may appear to be too few and too imperfect to justify conclusions applicable widely to living plants under entirely natural conditions, nevertheless, made as they are upon fairly representative plants, they seem to render it very improbable that the absorption of water through their green parts is at all general or appreciable in amount among ordinary land plants. Whether in plants of special habit, with special structures which may be used for the purpose (as epiphytic Bromeliaceæ, etc.), such absorption takes place is another and distinct question, and in some cases has proved, and in others may prove, answerable in the affirmative, consistently with an equally emphatic negative for ordinary land plants.

Phanerogamic Laboratory, Harvard University.

The Ware Collection

of Blaschka glass models of flowers at Harvard.

WALTER DEANE.

In the botanical museum of Harvard University is to be seen a collection which is absolutely unique in every way. It is the Blaschka Glass Flower Collection, presented by Mrs. Elizabeth C. Ware and Miss Mary L. Ware, in memory of Dr. Chas. E. Ware, of the class of 1834. These flowers are intended to illustrate the typical forms of phenogamic vegetation in America, and certain forms of the cryptogams will also be represented. The work is being done by the artists, Leopold and Rudolph Blaschka, father and son, living in Hosterwitz, Germany. It was through the untiring energy of Dr. Geo. L. Goodale that these artists were induced to abandon their work of making glass models of animals, chiefly marine invertebrates, which were sold to museums over the world, and devote themselves entirely to the construction of plants. They were, however, finally persuaded, on their own terms, to give their entire time to this work, and, by the last contract executed in Dresden in 1890, a certain number of models are to be sent to this country twice a year, for ten years. An American garden around their house supplies them with North American plants, while, from the royal garden of Pilnitz near by, they secure specimens of the vegetation of Central and South America. Leopold, the son, visited this country in 1892, and, in his travels to Jamaica and over our West, he prepared himself, by studies in color and collection of material, for the production of over 200 species.

Certain secrets are in their possession, such as the use of color, the preparation of the more fusible kinds of glass, and a peculiar method of annealing. The process is not, in any sense of the term, glass-blowing. Dr. Goodale, who alone has been permitted to see the artists at work in their studio, was astonished at the rapidity and deftness with which they accomplished their wonderful results. They each average 50 plants a year, and, when the amount of labor, and the fineness of detail are considered, this is truly marvellous. Already 450 large and 1800 small models are on exhibition here, displayed in plate-glass cases in well-lighted rooms. What I wish to call especial attention to in this paper is, not the economic or aesthetic side of these models, but their botanical accuracy.[1]

Has the general public, has even the scientific student any idea that the glass flowers in the Blaschka collection possess an accuracy of detail that is positively startling? The eye is at first attracted by the great beauty of the flowers, as they lie on their white cards in the glass cases, and, on a closer examination, we are more and more surprised and delighted to find nature so accurately followed in all those details that can be seen by the unaided eye. But surely the lens must reveal inaccuracies which are otherwise invisible. It seemed to me impossible that the artists could have produced a plant covered, perhaps, with minute flowers, with such exactness that any flower taken at random should follow the specific characters of that particular species, as if we had the natural plant before us. The general end would be subserved if the aesthetic features were kept in view, and a reasonable care in the finer points were shown. Even then the work of the artists could not be too highly commended. But, surely, nobody could expect to find the right number of stamens in every flower, the proper degree of pubescence on the stem, and such other characters as only a microscopic examination would reveal. It was to test this question of botanical accuracy in those finer details that I made a critical study of a number of specimens taken at random from various orders. I compared each plant with my own herbarium specimens, relying more on the natural plant than on the printed characters. In this way I could see many fine points which are not described in the books.

The first specimen was *Aster Novæ-Angliæ* L., var. *roseus* DC. The upper half of the plant is represented, besides four magnified portions of the flower-head. The hirsute stem and the numerous auriculate finely pubescent leaves are perfectly represented, but, when one examines the inflorescence, the wonder deepens. As far as the delicate fingers of the artists, guided by a most accurate knowledge of the complex structure of this flower-head could accomplish it, everything is present. The linear recurved scales of the involucre, the

[1] For further information on the inception of this collection, see the article on the Blaschka Glass Flower Collection in the Harvard Graduates' Magazine for July, 1893.

roseate rays showing even the styles (for in Aster the ray-flowers are fertile), the discoid or central flowers, are all clearly depicted. This is true not merely in a single head, but in them all, without exception. The young buds, showing only the involucral scales, are very natural, while in the older buds the rays are erect, not having fully expanded, and all the discoid flowers show only their small rounded tops. In the fully developed heads the central flowers have opened, and the syngenesious stamens show their yellow anthers in the outer row or rows, as one head is older than another. Herein the artists have shown their wonderful skill. Their models are the living plants, and every flower has its separate pattern, no two being exactly alike. They are not all cast in one mould.

In the older heads the central flowers have all opened, the stamens cover the surface, and the rays are incurved with withering tips. In this species, as well as in all the others, the magnified portions have been done with the greatest accuracy, and afford a fine object lesson. An involucral scale shows the glandular pubescence, and a floret, enlarged thirty times shows the hairy akene with the pappus of capillary bristles upwardly barbed, while the tips of the five-lobed corolla have their peculiar rosy hue, so different from that of the rest of the floret. The stamens pointed at the top and the forked style are all there too. The systematic analysis of this Aster can easily be made from the model, so perfect is its construction.

I have thought it best to give these details in the case of one plant, so difficult to produce, but, in the case of the others, which were as carefully studied, to give the important features of only a few. I found the same fidelity in matters of the slightest detail. Sixteen species I examined by careful comparison, besides making a more general observation of a large number. I sought faithfully to find some error, something systematically wrong. A fair criticism should disclose whatever faults may exist, but I failed to find such faults, with the exception of a very few cases, where some feature was not quite like that of the type species. The artists drew largely for their material from cultivated specimens of our plants, and in the few cases where some slight detail is not quite typical of the species, I am confident that this is owing to the fact that variation is apt to occur in plants under cultivation. There is such rigid observance of the very minutest features in every other case that we can be absolutely sure that every model is an exact copy of the fresh specimen which the artists had in hand.

Steironema ciliatum L. exhibited most beautifully all the fine characteristics of that gamopetalous species. The cuspidate-pointed, erose-denticulate corolla lobes, with stamens opposite these lobes, give the flowers a most natural appearance. Here, too, the varying age of the flowers is shown, from the tightly-closed bud to developing fruit. The ciliate petioles, a character to which the plant owes its specific name, are faithfully produced. The magnified stamen shows the fine granules on the filament, as they occur in the living plant.

In the case of *Aralia spinosa* L., the building up of the complex inflorescence with its multitudinous minute flowers, is almost past belief. In this cluster, with its flowers so small that their structure can be seen only with a lens, while many of its buds are so minute as to be indistinguishable to the naked eye, I counted, of buds, blossoms and developing fruit, from 2,500 to 3,000. And yet every flower has its five petals, and five alternating stamens with long filaments. I sought to find on the under part of the cluster some flowers perhaps less carefully done, as being practically out of sight, but they were all equal in their perfection. The immense compound leaf shows the spines scattered irregularly along the stalk and midribs. The pale under surface of the leaflets is quite invisible owing to the position of the leaf on the card. Were every specimen in the collection to be inverted, the same accurate work would be seen.

It is needless to multiply cases. It would be a continued record of what has already been described. Such wonderful work as this could have been done only by those whose love for nature and nature's works was deep. This love, combined with a master's skill, has produced a result never before equalled. How can we sufficiently admire the conscience that will not allow the slightest detail to be overlooked where this omission might most naturally be expected, and the patience that makes the last flower as accurate as the first, though there be hundreds on a single plant.

Each flower of our common milkweed, *Asclepias Cornuti* Decsne., shows the interesting features of this genus. I counted forty-four flowers, and thirty buds, and in each case there were the five hoods with their incurved horns surrounding the stigma. No two leaves were alike, but they exhibited the variation observable in this species.

The delicate corollas of *Teucrium Canadense* L., the wood sage, show their four exserted stamens. The blue flowers of *Polemonium cæruleum* L. are rendered wonderfully perfect by the five stamens, with hairy base, and fine 3-lobed style, while *Euphorbia corollata* L., in its singular involucre, contains the sterile flowers, each consisting of but a single stamen, and, in many cases, the fertile flower protrudes with its 3-forked style, each fork showing under the lens that it is cleft at the end. Here again the natural character is shown in the fact that the fertile flower is in various degrees of development; in some cases not yet visible, and in others with its ovary drooping over the side of the involucre. The lens is necessary to detect all this. I would call special attention to the inflorescence of *Alisma Plantago* L., which is wonderfully accurate, and also to *Hordeum jubatum* L., a most successful attempt to copy the long-awned spike of this grass. The magnified portions show the structure of the flowers.

But enough has been said to show the marvellous care and accuracy of the artists in all their work. Every plant tells the same story of nature closely followed out, and I am glad to bear my testimony to the almost magical work of Leopold and Rudolph Blaschka.

Cambridge, Mass.

The influence of mechanical resistance on the development and life-period of cells.

FREDERICK C. NEWCOMBE.

Introduction.

The question as to what actively growing plant tissues will do when their growth is checked by external mechanical resistance had received but small notice in literature till the appearance of Pfeffer's[1] latest published work. Some years ago, however, De Vries,[2] by winding stems with twine, found that the cambium gave rise to fewer cells under this resistance and that the wood elements expanded more slowly. Krabbe[3] by applying a graduated pressure to the trunks of trees, found the cambium cells uninfluenced either in size of lumen or in thickness of wall both when the cambium was forming new cells under various pressures and when the formation of new cells was entirely stopped by sufficiently increasing the resistance. This author confirmed De Vries' observation stated above, that the time between the formation of a wood element and its definitive condition was lengthened by increasing the pressure under which it grew. Wortmann[4] placed bandages of twine about the stems of seedlings of Phaseolus multiflorus and two other seedlings and found within a few days that the subepidermal collenchyma was abnormally thickened. This thickening he used to strengthen his theory of growth, believing that cell-walls grew thicker than normally when they could not reach their normal surface extension.

Pfeffer in the work referred to enclosed the root-tips of several species of seedlings, the stems of a few species, the growing points of Chara and Nitella, and the filaments of Spirogyra in gypsum casts. From the behavior of these preparations he deduces these results:

[1] Pfeffer, Druck und Arbeitsleistung. Abhandlungen der könig. säch. Gesells. der Wissenschaft **20**: —. 1893.

[2] De Vries, De l'influence de la pression du liber sur la structure des couches ligneuses annuelles. Extrait des Archives Neerlandaises 1876. Also, Vorlaüfige Mittheilung, Flora —: 97–102. 1875.

[3] Krabbe, Ueber das Wachsthum des Verdickungsringes und der jungen Holzzellen in seiner Abhängigkeit von Druckwirkungen. Berlin, 1884.

[4] Wortmann, Beiträge zur Physiologie des Wachsthums. Bot. Zeit. **47**: 286. 1889.

1. Embryonal tissue preserves for a long period in a gypsum cast its capability for growth.

2. In gypsum casts the differentiation of tissue advances nearer the growing point than normally, thus necessarily shortening the zone capable of elongation.

3. The cells of the embryonal tissue do not divide when their extension is prevented, but the cells of the tissue adjacent to the embryonal tissue do, in some plants at least, divide at a size somewhat less than their normal.

The following pages contain further observations on the questions already stated and besides show the effect of external mechanical resistance on

1. The duration of the growing period of cells;
2. The duration of the life period of cells;
3. The permanent condition assumed by cells.

This work was begun in Leipzig under the direction of Professor Pfeffer and completed in Michigan University since the author's return.

Methods.

The method used to arrest growth by mechanical means has been the employment of gypsum casts.[5] An organ to be encased had fitted about it an envelope of stiff paper closed at the bottom by a divided cork, by molding clay, or by cotton wool. A thick mixture of gypsum and water was stirred up and poured into the envelope and there allowed to harden. Two precautions are necessary to the securing of good results: the cast must have a diameter several to many times that of the organ encased to prevent springing by the energy of turgor;[6] the cast must have a length of three or more centimeters, since experience has shown that disturbing factors come into play in proximity to the limits of the gypsum envelope.

At the close of the experiment, the preparation was cut from the plant, the enclosed organ removed from the cast and subjected to microscopical examination. To free the organ from the gypsum, two longitudinal trenches were cut with a

[5] Pfeffer has used this method in researches for some time and has described it in *Berichte d. k. saechs. Gesellsch. d. Wiss.*, Dec. 1892: Ueber Anwendung des Gipsverbandes für pflanzen-physiologische Studien.

[6] Krabbe found the outward pressure of turgor under a ligature to reach fifteen atmospheres in the stems of dicotyledonous trees (l. c.), and Pfeffer found the pressure given by the roots of seedlings in gypsum casts to reach in some cases twelve atmospheres, while in the stems of some seedlings the pressure was six and one-half atmospheres. (Druck u. Arbeitsleistung, p. 188.)

knife or saw from opposite sides of the cast down nearly to the plant organ enclosed. The halves were then easily broken apart without injury to the plant tissue.

The cells were regarded as living or dead according as plasmolysis was present or absent after placing sections in a ten per cent. solution of potassium nitrate.

The following plants were used in the experimentation:

Allium cepa L.,
Althæa tauriensis DC.,
Archangelica sativa Mill.,
Caltha palustris L.,
Cucurbita pepo L.,
Dahlia variabilis W.,
Equisetum limosum L.,
Eryngium planum L.,
Forsythia viridissima Lindb.,
Helianthus tuberosus L.,
Juglans nigra L.,
Juncus effusus L.,
Lamium garganicum L,
Ligusticum Leguari,
Melianthus major L.,
Myrrhis odorata Scop.,
Phaseolus multiflorus Lam.,
Phytolacca dioica L.,
Pterocarya fraxinifolia Nutt.,
Ricinus communis L.,
Sambucus nigra L.,
Triticum repens L.,
Urtica dioica L.,
Vicia faba L.,
Zea mais L.

Experiments and discussion.

Effect of mechanical resistance on the growth and preservation of meristematic tissue.

In operating upon the growing points of the roots and stems of several species of seedlings, Pfeffer[7] found that within a gypsum cast which prevented all extension of tissue, the ability for growth was retained for many weeks. In the cases tested, growth was immediately renewed on removal of the cast. Here, then, with all the conditions of growth favorable, except the space in which to extend, the primary meristem retains its functional capability as it does when obliged to rest by low temperature or by insufficient moisture. Pfeffer found also the growing tips of Chara and Nitella living after being three months in gypsum.

My own experiments have shown that intercalary meristem and cambium as well as growing points retain their functional capability for long periods when their growth is prevented by similar gypsum casts. In Juncus, as is well known, the meristem for the growth of the aerial stems is at the place where such stems grow off from the rhizome. Casts were placed around the bases of many stems and about the rhizomes so as to include the zone of meristem. Some of these preparations were examined five weeks afterward, some after eleven weeks.

[7]Pfeffer: l. c., p. 124.

The cells of the meristematic zone were in all cases living and normal in appearance at both periods of examination.

The growth of the leaves of Allium cepa is also intercalary; the meristem is at the leaf-bases. Several experiments were made on this plant by including within a cast the upper part of the bulb and the young leaves which had started from it. The cast was then fastened by bandages to the bulb so that bulb and cast could not separate, yet so that the roots could grow out freely. The preparations were examined, some at the end of two weeks, some after thirty-one days. The results were the same in all cases. The meristem remained alive, and growth was resumed upon removal of the casts.

The effect on the cambium of arresting its growth by external resistance has been determined by enclosing within gypsum casts the stems of many plants both herbaceous and woody. To prevent by this method all extension or growth in the cells within is impossible, since the presence of intercellular spaces always affords some room, and the resistance of vessels is not sufficient to withstand the force of turgor of the thin-walled cells. Thus, though the cambium has not been held in these experiments, and could not be, in a state of absolute rest as regards growth, its activity in this direction has been, as will be seen, very slight. The amount of growth from the cambium in such circumstances must depend entirely on the room it can make for itself, and differs therefore in different species of plants, and differs also in the same species, since the size of the intercellular spaces and the turgor of a tissue will differ with age. In young stems of many plants the primary meristem of the fibrovascular bundles has been preserved in an almost quiescent condition for several weeks. Rarer examples of long continued rest have been furnished by Lamium garganicum, Vicia faba and Dahlia variabilis in which so slight was the development within the casts that for 40, 50 and 120 days respectively the formation of the interfascicular cambium was prevented, though it was formed immediately below and above the limits of the casts, and the growth of the plants as a whole continued. Yet notwithstanding this long rest the primary meristem was apparently and undoubtedly capable of farther active growth.

In cases where the casts were applied after the cambium zone was completed, there are many individuals, representing several species, bearing testimony to the long preservation of this meristematic tissue when its growth is mechanically checked. In none of these cases were the experiments continued till the death of the cambium, and hence the duration of its vitality, when its growth is mechanically prevented, is still undetermined. Pfeffer, in the work mentioned, states that the root-tips of Vicia faba in casts remained alive for five weeks, but that at the end of ten weeks had begun to die. The cambium certainly lives longer under similar conditions. Cucurbita pepo with considerable growth of stem outside the cast and very few changes within the cast has preserved its cambium for sixty-six days. Eryngium planum and Ligusticum Leguari about whose stems casts were placed at the time the cambium ring was completed, grew well afterward, forming outside the casts normally thick stems, and at the time the plants were taken for examination had produced seeds; the cambium was thus preserved in these species for seventy days. Young plants of Vicia faba grew after the second or third epicotyledonary internode had been encased in gypsum to a size and development equalling normal plants and had seeds partially formed when the plants were cut for examination 116 days after placing in gypsum. Dahlia variabilis does not grow very well when a cast is put around a very young stem. Several individuals however added half a meter to their height and were still growing and had healthy looking cambium within the cast 138 days after the beginning of the experiment. Pterocarya fraxinifolia, Juglans nigra and Forsythia viridissima formed branches in most cases as well developed as normal ones, though the same branches when young had had gypsum laid around them, and within the cast formed but few seconday elements, Forsythia in one case forming but four or five in a radial row. This experiment was continued for seventy days, at the end of which period the cambium appeared normal. In similar conditions and with similar results Sambucus nigra was grown for ninety-six days, Ricinus communis for 100 days and Phytolacca dioica for 197 days. In the last named plant, in one stem, there had been formed within the cast five or six cambial derivatives in a radial row after the experiment was begun, while above and below the cast thirty to thirty-five such cells had been formed.

It is to be understood that in all these cases the stems had increased greatly in diameter beyond that of the part within the cast; as extreme examples may be mentioned Vicia, Dahlia, Ricinus and Pterocarya where the diameter outside the cast was often to that within as two to one.

Effect of mechanical resistance on the duration of the period of development of cells.

1. *On the zone of elongation in roots and stems.*—When root-tips or stem-tips of seedlings are fixed in a gypsum cast, the power of elongation becomes day by day reduced to narrower limits, so that when the growing point is released from its confining envelope, subsequent growth shows that the proximal limit of elongation is nearer the apex of the organ than formerly. Pfeffer[8] demonstrated this in several species. In the primary root of Vicia faba, for instance, where normally the elongating zone is about 10^{mm}, he found this zone reduced to 5^{mm} or 6^{mm} after two or three days in a cast. My own measurements have shown that in a normally growing primary root of Vicia faba at a temperature of 20°, the fourth millimeter from the apex of the root will in twelve hours have passed out of the segment of elongation. But Pfeffer's root-tips showed elongation in the fifth or sixth millimeter after two or three days in casts. Thus it is evident that the effect of the casts was to retard the passage of the elongating segment into permanent tissue.

Analogous with this result is that obtained in my experiments with Juncus and Lamium, where several very short shoots of the former in which tissues were undifferentiated were kept alive for eleven weeks in casts, and then showed no differentiation; and in the latter the stem just behind the terminal bud was, in one case for twenty-five days, in another for forty-five days, by the same means kept from developing farther, except that two or three cells in the primary bundles slightly thickened their membranes. Meanwhile the stems had grown above the casts and the tissues had become much better developed than within the casts.

2. *On differentiation in fundamental parenchyma.*—Not only in the tissue adjoining the meristem of growing points will development proceed more slowly when a mechanical resistance prevents expansion, but in those later changes which in many plants the fundamental tissue undergoes will the same result follow. In Zea mais the cells which normally form the

[8]Pfeffer, l. c., pp. 120 and 149.

sclerenchyma sheaths have, by the employment of casts around the stem, been kept thin-walled for thirty-seven days, in Caltha palustris for fifty-two days, though these cells remained alive and in the same stems above and below the casts passed into their thick-walled condition.

Other plants in which the outer zone of pith-cells normally becomes thick-walled have served still better to illustrate this principle. Numerous examples of Vicia faba have shown that the outer pith-cells begin to thicken their membranes two or three weeks after their internode is fully elongated. If, however, a cast is laid around a very young internode, the thickening of the membranes of the pith-cells will be delayed for weeks after it has begun in the internodes of the same stem above and below the cast. Thus in a stem that had grown to the height of ten internodes, whose third internode above the cotyledons had been encased in gypsum before elongation was complete, the subsequent period of growth being thirty-two days, the pith-cells beyond the limits of the cast were becoming thick-walled, while within the cast they retained their thin-walled condition. Other plants of the same species similarly treated but allowed to grow twelve days longer, at which time they had added to their height and begun to blossom, showed within the limits of the casts the outer pith-cells just beginning to thicken their membranes. Similar preparations, but twelve days older, and consequently of stronger development, showed the outer pith-cells with membranes thickened, but still thinner than in normal parts of the stems. Urtica dioica, twenty-three days after two or three young internodes were enclosed in a cast, had above the casts thick-walled pith-cells bounding the inner ends of the bundles, but only thin-walled cells in similar positions within the casts. Other stems growing for forty days after casts were applied in like manner, showed within the casts the outer pith-cells with thickening membranes. In Dahlia variabilis the outer cells of the pith have by means of casts been kept thin-walled ten weeks later than in neighboring normal parts of the same stems. Still older preparations have shown however that if growth in the plant as a whole continues these cells will eventually become thick-walled. Archangelica sativa and Myrrhis odorata form a broad zone of mechanical pith which bounds primary and secondary xylem internally. Segments of stems of these two species have presented within casts the pith entirely thin-walled, when above and below the casts the zone of fully thickened pith-cells has been six cells in radial width.

If we turn now to woody plants we shall find the same results presenting themselves. Several shoots of Melianthus major had casts placed around them so as to leave only the terminal bud exposed above. Up to the time when three internodes had been subsequently developed there were no thick-walled cells in the pith of the segment in cast, but above and below the cast there was a broad band of thick-walled lignified pith. In shoots similarly prepared but of farther development above the casts, there was always an evident thickening of the outer pith-cells within the limits of the casts, this thickening progressing in the older preparations till it approached that of like cells outside the confined area. The same general results were obtained by similar experiments with Forsythia viridissima and Pterocarya fraxinifolia.

Many plants which have collenchyma in the cortex of the young stem do not, as is well known, increase the amount of this tissue as growth proceeds, while others with increasing age in an internode show the collenchyma increasing in number of cells and thickness of membrane. Sambucus nigra belongs to the latter class. When in the spring very young shoots have some of their internodes enclosed in gypsum and are allowed to grow subsequently, the increase of the collenchyma is found to be more tardy within the casts than outside of them, though the thickening of cell-walls is still slowly progressive within the casts.

In the young stems of Archangelica sativa and Myrrhis odorata the collenchyma strands of the future exist in a very thin-walled condition. By laying gypsum around segments of such young stems, the strands referred to have been in Archangelica for twenty days, in Myrrhis for twenty-seven days, kept in their thin-walled condition, while above and below the limits of the casts the strands in the same time formed very thick-walled collenchyma. How much longer these cells would have remained thin-walled within the cast was not determined by other experiments; but that they were still capable of growth there can be no doubt, for they were at the time of examination well provided with protoplasm.

The fact that the sclerenchyma of the fundamental tissue develops more slowly against mechanical resistance has been mentioned for Caltha palustris and Zea mais. The same is true of the only other plant in which the question was studied, viz., Cucurbita pepo. In this plant after elongation of the internodes the innermost cortical cells thicken into a heavy zone of sclerenchyma. In internodes confined in casts this zone has been delayed in development into sclerenchyma for several weeks, though it could there be identified as a band of thin-walled cells. Older preparations have shown this band becoming slowly thick-walled, the progress continuing after the full thickness of wall had been obtained in parts above and below the cast; though in the oldest preparation examined these cells had not become so thick as in normal parts of the same stem.

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[*To be continued.*]

BRIEFER ARTICLES.

Compass Plants.—I was among the first to be interested in the peculiar twisting of the leaves of the *Silphium laciniatum*, and my paper published in 1865, in the "Proceedings of the Academy of Natural Sciences of Philadelphia," shows how closely the curious plant attracted me. There were some lingering doubts about the "polarity" of the leaves, till one day, when in St. Louis, my good friend Dr. Engelmann, took me to a waste lot in that city, where *Lactuca Scariola* had just secured a foothold. He was a strong believer in polarity, and I gave up. I have, however, continued for a quarter of a century to look for additional facts. It is surprising, if we look closely, how many plants we shall find twisting as Mr. Foerste describes the leaves of some doing (this journal, *ante*, p. 35). Possibly the best of all to study are *Gaura parviflora*, and *Chrysopsis villosa*. With a prepossession in favor of "polarity" I used to think I saw in these good evidence thereof. Continuous and careful watching proved I was wrong. I have long had to abandon this hypothesis in all except the Silphium, as a single plant in my garden is not a fair test. Not seeing them in any quantity I have to be simply an agnostic in regard to its "tendency to evade the direct rays;" and many other suggestive explanations I have also had to abandon.

A few years ago, I found myself at Gettysburg a day ahead of time. Of course it was devoted to botany. *Lactuca Scariola* had got there before me, and was in considerable quantity in some portions of that sacred ground. I walked and sat among them a couple of hours, determined it should give up to me the secret of its upturned leaves. With some strong shoots of species of Solidago before me, I was reminded of a strong but cordial controversy by letter, extending over some time, that I had had in the past with Dr. Asa Gray, I affirming that the leaves of plants do not originate at the nodes from which they appear to spring—a point, by the way, I can more strongly defend to-day. It could be easily seen, by these Solidago stems, that the leaf blades had twisted pentamerously around the stems from some indefinite point below, the edges of each leaf *overlapping*, just as paper overlaps when the confectioner twists a piece of paper into a "cornucopia" bag to hold the sweetmeats; and that leaf blade, as we finally come to understand the term, is the last crowning act of the spiral growth. With this key it did not take long to open the Lactuca mystery. The whole of my quarter of a century of search seemed rewarded. I have since used the key to the mystery in other plants, and the treasure-box opens as easily. It is the same answer all round. *The twist is the result of a somewhat prolonged effort of spiral growth*, and of no physiological value whatever.

I was for a time puzzled by a certain uniformity in the direction of the leaves—not by any means always with the edges north and south. Especially was I puzzled in noting that the first opening of a flower of *Helianthus mollis* was to the south-east. But here came in what I think is a point I have established, that growth is rhythmic and not continuous, and that growths that start together are likely to rest together. A quantity of seeds, starting at the same time under the same day's warm sun, would naturally have similar resting phases. Seeds starting at other times, or under some peculiar conditions of vital power, would disarrange total uniformity in results.—THOMAS MEEHAN, *Germantown, Philadelphia.*

An additional poisonous plant.—D. T. MacDougal (Bulletin 9, part 1, Jan. 16, 1894; Minnesota Botanical Studies) gives in a convenient reference list the plants of Minnesota known to be poisonous, producing the symptoms called by physicians *dermatitis venenata*, or rhus poisoning. He mentions two species of Ranunculus in his enumeration, *R. septentrionalis* Poir. and *R. sceleratus* Linn. *Ranunculus acris* L. must be added to the list of known or reputed skin irritants, as the following account will show. This species, preserved in alcohol for over a year, was distributed to a university class for study, and in doing this the fingers and hands were frequently immersed in the alcohol of an olive-green color. A day or two afterwards an intense itching sensation was experienced. The softer skin between the fingers became red and covered with minute watery vesicles, or pustules, and after the inflammation had disappeared, the skin of the fingers began to crack, as if they were chapped. These symptoms were exactly similar, in my case, to the effects produced by contact with the poison ivy, Rhus toxicodendron. The watery acrid juice, so universal in the Ranunculads (dissipated in many forms in drying), had been extracted from the plants, and evaporating on the surface of the hands left behind the precipitated active irritating principle.

The wide distribution of the poison sumachs has been accomplished by the carrying of the drupes in the stomachs of birds. An instructive fact, which has come to light recently through the examination of crow stomachs, is the discovery that the fruits of the poison sumach, Rhus venenata, and poison ivy, Rhus toxicodendron, are eaten in large numbers by the crow. W. B. Barrows has in one case recorded that 153 seeds of the poison ivy were found in a single stomach. A single pound of dried excrement taken from a roost in the National Cemetery at Arlington, contained by actual count 1041 seeds of Rhus toxicodendron and 341 seeds of Rhus venenata, in addition to 3271 seeds of other sumachs, 95 seeds of Juniperus Virginiana, 10 seeds of Cornus florida and 6 seeds of Nyssa sylvatica.—JOHN W. HARSHBERGER, *University of Pennsylvania, Philadelphia.*

EDITORIAL.

THERE ARE many advantages in being in the current of the world's activity. Botany is restrained in its development, and shorn of just recognition, because its representatives are still largely willing to paddle about in quiet bayous, content with the richness of botanical materials and the opportunity of uninterruptedly studying them, without giving a thought to the great interests involved in the surging, pushing mass of commerce and daily traffic which pass near by, accompanied by the noise of enginery and the display of competition. A well known botanist, who has occupied a public position for many years, explained to the writer some time ago that he preferred to go without much needed facilities in the way of books, room and assistance rather than make a request for them or do anything that would attract the attention of the politicians, who would probably abolish the office or bring about some calamity if they remembered that he was in existance. This feeling is a survival from the old days when the botanist was a scholarly recluse, and neither he nor any one else dreamed that his knowledge could have a cash value. Botany was taught then, and is often taught now, as Arabic or quarternions are taught, not because it would help one to gain a livelihood, but for its disciplinary and educational value.

A MIGHTY CHANGE has overtaken the spirit of the botanist in recent years. He has emerged from his herbarium den, and looks at the world with a clear eye instead of constantly peering through a magnifier at a bit of unrecognizable vegetation; he is occasionally seen in cultivated fields, instead of prowling through thickets and out of the way marshes; he speaks like a man who is watching for an opportunity to develop a new industry, and no longer acts as if he fully believed that industries and botanical science are unrelated and incompatible.

But the transformation is not complete, in fact it is only so far along as to make its tendencies clearly recognizable. There are still good botanists who will not admit that there is any actual change. They are content that the study of the food of plants should be carried on by chemists, the investigation of the laws of breeding and practical treatment of diseases by horticulturists, the relation of plants to heat, light and electricity by physicists, the study of bacteria by pathologists, the examination of fossil plants by geologists, and so on. In repudiating the connection of these and other lines of investigation with the science of botany, especially where a practical or commercial end is in view, the botanist loses the advantage derived from popular approval. It is more difficult to obtain ten dollars to equip a laboratory for vegetable physiology than a thousand dollars for a labortory of chemistry, because Baron von Liebig and others long ago fully convinced the popular mind that a knowledge of chemistry was essential to an intelligent pursuance of most of the arts and industries. And so thoroughly was this done that every man, even to the present day, although he may not know the names of the elements, associates chemistry with the indispensable in education, while he has hazy, if any, notions about vegetable physiology or its application. A Liebig is needed in botany.

It is a sound principle in advertising that having an article of genuine worth and general utility the profit from it will be in proportion to the extent to which it is made known. Botany, both as a fundamental and as an applied science, is in some respects like a commercial article. The better its merits are known the greater its income will be in the way of money for teaching equipment, for laboratories, for research, for salaries, for assistance, the more and varied the demand for botanists, in short the greater activity and the greater possibilities.

The progress already made toward creating a need for botanists in the commercial world is considerable, and is every year increasing the demand for well trained men. At present the most promising field is vegetable pathology. In this line the action of the orange growers of Florida is significant. They have endorsed and substantially aided the Sub-Tropical Laboratory at Eustis, and recently have formed a stock company to send a botanist around the world to collect and study citrus and other sub-tropical fruits, to observe their diseases, and in every way possible to make available whatever knowledge an able botanist can gather with practically unlimited resources. A method of caring for orchards and vineyards, likely to be introduced by some enterprising community, is the employment of a pathologist to take charge of the health of the plants, spray them at suitable intervals, and to be on guard against parasites. There are at present many ways in which botanical knowledge can be made to yield a livelihood beside teaching. The greater and more diversified the demand for men trained in botany becomes the better it will be for all branches of the science, and for all its devotees.

CURRENT LITERATURE.

A Californian Manual.[1]

It has long been recognized that the flora of the Pacific coast is a wonderfully rich one, and that detailed exploration is almost daily bringing to light new plant forms. It has also been a matter of regret that no handy manual brought even an outline knowledge of this flora within reach of those to whom botanical libraries are not accessible. The " Botany of California," in two large volumes, is a monument to the generosity of certain citizens of that state, and it formed a fitting foundation for study; but it is both costly and hard to get, and is now far from expressing our knowledge. Keen collectors have been plentiful upon the Pacific coast, and it seemed hardly worth while to prepare a manual which must of necessity be incomplete before it could get through the press. The most indefatigable student of this flora has been Professor Greene, as his numerous publications will testify. His "Flora Franciscana," appearing in parts, is already well known, and now he has presented a manual of the same region for the benefit of the schools and colleges, and all students desiring "to make some beginnings in the systematic botany of middle western California." But nine counties are included, and ninety natural orders of flowering plants, the sedges and grasses being notable omissions, and the indications are that a complete manual of the whole state would be a huge affair. The author's purpose is most commendable, and we do not doubt that the book will be a great boon to beginning students in the "Bay-Region." Besides, no botanist has so intimate a knowledge of the flora of the region presented, and hence no one is so well fitted to act as guide.

Our only criticism is from the standpoint of the professional botanist. Professor Greene says that "there is much that is new for the bibliographer and the nomenclator within these pages;" also that "this feature will not in the least affect the usefulness of the manual as a book for beginners;" but that "the inconvenience will be realized only by the experienced botanist." We heartily agree with all three of these propositions, especially the first and last, for there is very much that is new for the bibliographer, and it is the most inconvenient book for the experienced botanist that it has been our fortune to examine. Knowing how thoroughly the author appreciates

[1]GREENE, EDWARD LEE.—Manual of the Botany of the Region of San Francisco Bay. 8vo. pp. xiii, 328. San Francisco, 1894.

the value of frank criticism, of which he has become so distinguished an exponent, we venture to confess ourselves discouraged by this book. It gives one so constantly the impression of straining after changes, that we find it hard to rid ourselves of the impression. One expects a reasonable amount of this in generic and specific combinations, for we can hardly move without jostling these; but when it attacks ordinal names, sequence, everything, it makes one wonder how very completely all other botanists have gone astray. Possibly this impression may wear off. The very great inconvenience of the book to the professional botanist is the entire omission of synonyms. It can hardly be expected that a botanist in these days can carry in his head all the permutations of nomenclature, for it would be as impossible and about as profitable as to remember the daily weather reports; and it also cannot be expected that he will have time to look up the synonymy in various publications. This seems to us a more serious defect than the omission of an index. Our feeling of discouragement, however, chiefly arises while contemplating the generic names and their reference. It seems to us that if Galen, and Theophrastus, and Vergil, and Pliny, *et id omne genus*, are to be consulted for generic names, bibliography at once becomes an impossibility and systematic botany the common dumping ground for all literature. There is no reason why the wonderful Semitic libraries should not add their clay volumes to the confusion, for they indicate and name many a plant that has been clearly identified. We are very glad that the author has said that "no botanist will be obliged to adopt the nomenclature of the Manual of Bay-Region Botany," and we sincerely hope that they will follow this wise caution. Of course, he means to say that if we do not like it we can say so, a privilege of which we are glad to avail ourselves, and we therefore enter our protest against this use of pre-Linnæan names. We ourselves have participated in revolutions of nomenclature in the interest of peace, and not that one revolution may simply be the prelude to another. We have thought that one thorough resurrection of names since systematic botany became a science might be necessary to their permanent burial decently and in order, but we do not expect to be parties to a perennial resurrection. Highly as we esteem Professor Greene we cannot just now follow him any further in this ghoulish business, and we trust that he will understand that we have deserted him, not for his own sake, but on account of the company he keeps.

Revision of Guttiferæ.[1]

This latest volume of a series of famous monographs, which form a continuation of the *Prodromus*, is the last one to bear the name of Alphonse De Candolle. In a prefatory note the son, Casimir, promises that the third generation will continue the work on the same plan. The volume is also interesting because M. Vesque has made large use of minute anatomical characters, including them everywhere in his descriptions. In the preface the author discusses the value of such characters and emphasizes the importance of their increasing use in recent systematic work. The limitation of the family is along the old lines, the *Hypericaceæ* and certain genera of *Ternstroemiaceæ*, which are included by Engler in *Die Natürlichen Pflanzenfamilien*, being excluded. The *Hypericaceæ* are not excluded on the basis of the distribution of resiniferous canals, as suggested by Van Tieghem, but are regarded as entirely distinct on many grounds, strikingly so in minute characters. For instance, the hairs, the stomata, the oxalate crystals, all oppose such union. The stomata of *Guttiferæ* are constantly of the rubiaceous type, that is, with two accessory cells parallel with the cleft; while those of *Hypericaceæ* are as constantly of the cruciferous type. Such work is to be expected of M. Vesque, who sees in minute anatomical structures the same principles of evolution developed, indicating genetic relationships, that we have been accustomed to apply only in gross structures. Under each species the two sets of characters are distinctly separated, his "epharmosis" giving a compact account of the histological peculiarities. One cannot but feel amazement at the immense amount of work such treatment involves. This great tropical family, of which the large tribe *Clusieæ* is exclusively American, is represented in this monograph by 495 species, forty of which bear the name of M. Vesque as author. The three large genera are *Garcinia* of tropical Asia and Africa, with 186 species; *Clusia*, of tropical America, with ninety-six species; and *Calophyllum*, of the tropics in general, with sixty-four species.

A curious and quite effective method of presentation is used in the discussion as to the value of "epharmonic" characters, in relation to the large stress put upon the development of the hypoderma. Two botanists, A and B, are represented as debating the question and taking opposite views. Naturally A, who adopts the value of "epharmonic" characters, easily prevails over the opposing B.

[1] VESQUE, J.—Monographiæ Phanerogamarum, etc., Alphonse and Casimir DeCandolle editors, Vol. VIII, Guttiferæ. 8vo. pp. 670. Paris: G. Masson. Dec. 1893.

The biology of ferns.[1]

We are somewhat puzzled to discover from what point of view we should criticise this book. To classify it is difficult. It is strictly neither a student's handbook nor a treatise, but something of a combination of these. Nor is it sufficiently either one or the other to demonstrate clearly its *raison d'être*. We have asked ourselves how we could use it; and the answer seems to be that it will be convenient to have the figures and the facts it contains in one book instead of in several; to have some fresh illustrations, instead of those already familiar; and to have some concrete directions for collodion imbedding to supplement the general and comprehensive ones.

By this we do not mean to imply that the book is merely a compilation, for the author and his pupils have done a large amount of (in a sense) original work for it; yet there is not much in it that is really new. Nevertheless it has ample value to assure it a wide welcome in botanical laboratories.

The book hardly seems to justify its title, if we understand it; for it treats not of the biology of ferns (which, we take it, cannot be studied by the "collodion method"), but of the morphology and comparative anatomy of ferns. In chapter I of the first part, Professor Atkinson describes succinctly the development of the gametophyte and its sexual organs. He then devotes three chapters to the development, morphology and anatomy of the stem, root, and leaves of the sporophyte, and two to its sporangia. Chapter VII discusses the substitutionary growths from sporophytic and gametophytic budding, apogamy and apospory, while VIII is devoted to an account of the Ophioglosseæ. Part II treats of the technique of collodion imbedding and cutting, raising prothallia, etc., and contains directions for study. A bibliography follows, listing the most important papers, which, however, are not directly cited in the text.

All of the figures are original, most of them are excellent, and some are extraordinarily fine, notably 49, 139 and 140. A very few are distinctly bad, as 57, 58, 59. Fig. 131 is obscure and might do duty for a diagram of a cyclone. Figs. 19–23 and 25–27 were apparently left unfinished accidentally, lacking the outline of the cell walls. It would seem better to put the initials of the artist at one side than to incorporate them with the tissues themselves. Nor can we quite see the use of drawing a scale with each figure unless the figure and the scale are magnified to the same degree. In every case where magnification is

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[1] ATKINSON, GEORGE F.—The study of the biology of ferns by the collodion method; for advanced and collegiate students. 8vo. pp. xii. 134. figs. 163. New York: Macmillan & Co. 1894.

shown it is stated in this form: "magnified 30 times more than the scale; scale=1^{mm}." Why not, "magnified *x* diameters;" or "scale $.05^{mm}$", drawing the latter with the same lenses as figure?

The book is gotten up in luxurious style, with heavy paper, wide margins and large type.

Minor Notices.

FOLLOWING his revision of our N. Am. species of Epilobium, Dr. William Trelease now presents, in his careful and thorough way, a revision of the small genera Gayophytum and Boisduvalia, six species of the former and four of the latter. Each species is illustrated by a plate showing general habit and dissections. These genera are peculiar to our western mountain region, and are also found in corresponding regions of S. America, but seem to be entirely wanting between. Dr. Trelease thinks that the indications are in favor of a former continuous distribution along the backbone of both North and South America. Gayophytum closely resembles the *paniculatum* group of Epilobium, and Boisduvalia was merged with Œnothera by Bentham & Hooker. The material is much confused in our herbaria, and this paper will do good service in helping us to proper identifications.

AN INTERESTING SYLLABUS of a course of lectures in biology has been issued by Dr. D. W. Dennis,[1] Professor of biology in Earlham College, (Richmond, Ind.). It is said of Oliver Wendell Holmes that he makes even an index attractive reading. A like ability is apparent in the present work, for the usual dryness of an outline of scientific lectures is relieved by the suggestive form of the topics, the numerous illustrative quotations and the range of the implied applications. The use of the word biology is also to be commended, as embracing the different fields of biologic science in a reasonably just proportion.

DR. J. W. MOLL describes[2] an oven for drying herbarium specimens rapidly. The apparatus is a double-walled oven with burners controlled by a thermostat. The chief novelty, however, consists in the use of corrugated paper, such as is used for packing bottles, between the sheets containing the plants. This hint may be good, even with the ordinary mode of drying.

A CONVENIENT host and habitat index of Australian fungi has been prepared by N. A. Cobb, government botanist of New South Wales. It is based upon M. C. Cooke's "Australian Fungi," and makes a pamphlet of 44 pages.

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[1] DENNIS, DAVID W.—Biology: syllabus of a course of ten lecture-studies. Earlham College: Department of University Extension, No. 3. [Richmond, Ind.]. 8vo. 20 pp., 10 cts.

[2] Separate from Botanisch Jaarboek **6**: 1–23, *pl. 1*. 1894.

NOTES AND NEWS.

THE APPENDIX of *Bulletin de l'Herbier Boissier* (Jan.) consists of a systematic conspectus of New Zealand Lichens, by Dr. J. Müller.

M. A. DE JACZEWSKI, in *Bull. l'Herb. Boiss.* (Feb.), reports the discovery of *Puccinia Peckiana* Howe in Switzerland, on Rubus saxatilis.

THOSE INTERESTED in the finer structure of the Desmideæ as applied to classification will find an important contribution to this subject on the pores of *Closterium* by Dr. J. Lütkemüller in the Œsterr. Botanische Zeitschrift **44**: 11, 49. 1894.

IN THE February number of *Erythea*, Messrs. Ellis and Everhart describe twenty-nine new species of West American fungi; Mr. Davidson concludes his field-notes upon Calochortus; and Mr. Bioletti gives some interesting experiences in herbarium making.

NAWASCHIN has not only fully established the fact that the so-called "microspores" of Sphagnum described by Schimper are the spores of a fungus, *Tilletia Sphagni* Nawas., but has worked out the life history of the fungus. See Bull. de l' Acad. Imp. des Sci. St. Petersb. **13**:394.

IN THE number of the *Journal de Botanique* for Jan. 16th M. Sauvageau continues his "biological notes" on the Potamogetons, P. crispus forming the subject of the present paper; and M. Bescherelle begins a series of descriptions of new mosses, the present fascicle being from Africa.

MR. A. P. MORGAN has continued his publication of the myxomycetes of the Miami Valley (Ohio) in Jour. Cin. Soc. Nat. Hist. **16**: 127-156, presenting the two orders *Stemonitaceæ* and *Didymiaceæ*, and illustrating with two plates. Comatricha, Didymium, and Diderma each contains a new species.

MR. M. A. CARLETON, for several years assistant in the botanical department of the Agricultural College at Manhattan, Kansas, has recently been appointed an assistant in the Division of Vegetable Pathology at Washington, D. C. Mr. Carleton will have for his special work the rusts of cereals and other plants.

THE *Journal of Botany* (Feb.) contains an account, with plate, of the development of the stem and leaves of Physiotium giganteum (one of the liverworts with auricles or water-holding sacs), by Jesse Reeves, in which the development and structure of the auricle are described, and the stem found to grow by a two-sided apical cell.

THE PLANTS of Central Africa are being gradually brought to light and their geographical affinities made out. The latest results are those of Dr. J. W. Gregory, who gave an account of his exploration of Mount Kenia at the meeting on Jan. 15th of the Royal Geographical Society (London). He found on the higher elevations a mixed flora, having affinities with the European and Mediterranean floras on the one hand, and with the South African flora on the other.

In a paper on the spore-forming species of *Saccharomyces* (Amer. Naturalist, 27: 685. 1893) one species was not mentioned, namely, the ginger-beer plant, *S. pyriformis* Ward, Phil. Trans. 183: 125. 1892. This species is one which easily forms spores at 25° C. in 40–50h; spores are also readily formed in gelatin cultures. This yeast lives with different bacteria in mutualistic symbiosis.—Bay.

Scab (*Oospora scabies* Thax.) on beets reduces their commercial value, although apparently a surface injury, according to analyses made by H. A. Huston (Bulletin Ind. Exper. Station, 5: 37. 1894). These analyses showed a decrease in the sugar content from 14% in healthy beets to 12.8% in scabby beets in one variety, and from 13.6% to 12.7% in another. Of the beets grown upon the station farm at Lafayette, Ind., some varieties showed at harvest more than half of the beets affected more or less with scab, while none had less than 10% affected.

Baron Ferd. von Mueller has published, under the authority of the Secretary of Agriculture, Australia, an "Illustrated description of thistles, etc., included within the provision of the thistle act of 1890," Melbourne, 1893, pp. 1–20 and twelve plates. The latter show habit and detail figures of *Carduus lanceolatus* (Linn.), *C. arvensis* (Tabernæm.), *C. pycnocephalus* (Jacquin), *C. Marianus* (Linn.), *Onopordon acanthium* (Linn.), *Centaurea calcitrapa* (Linn.), *C. melitensis* (Linn.), *Kentrophyllum lanatum* (Necker), *Xanthium spinosum* (Linn.); which names will give nomenclaturists something to think of! The plates are lithographed and beautifully colored.—Bay.

Tschirch discusses[1] in a late paper the formation of resins and ethereal oils in plants, both from the chemical side and the anatomical. He finds in the epithelial cells of resin passages no trace of resins, so that these are not secreted as such by these cells, but only the resinogenous substances. The resins and oils are, in most cases, first recognizable in the thickened part of the wall of the epithelial cells next the canal. He also discusses the relation between the carbohydrates, phloroglucin, tannins and resins, of which there is a series which is possibly significant of the chemical origin of the resins.

In the *Journal of Botany* (Feb.) Mr. A. Gepp gives a biographical sketch of Richard Spruce, who died Dec. 28th of last year, at the age of seventy-six. From the first of his botanical career he was a special student of mosses and liverworts, and in the last years of his life he devoted himself entirely to the latter, his "Hepaticæ of the Amazon and Andes" probably being his most important contribution. His great service to botanical science consisted in the large collections made during his remarkable and extensive explorations in South America, which were conducted unremittingly from 1849 to 1861. After his return to England in 1864 his life was passed in retirement.

In the *Bull. Torr. Bot. Club* (Jan.) there appear several important papers dealing with our flora. Mrs. Britton presents the N. Am. species of Orthotrichum; Mr. Small begins a series of studies of our S. E. Flora, including in the present paper descriptions of a new

[1]Pringsh. Jahrb. f. wiss. Bot. **25**: 370. 1893.

Amorpha from Ga., and a new Hieracium from Tenn.; Mr. Heller notes twenty-three Virginian species new to the manual range, and describes a new Pentstemon from N. C.; Dr. Britton presents his eighth paper on new or noteworthy N. Am. phanerogams, giving, besides other notes, a synoptical and bibliographical list of the N. Am. species of Stenophyllus, and proposing a new genus, *Meehania*, for *Cedronella cordata* Benth.; Mr. Coville deals with the genus Hemicarpha in N. Am.; and Professor Scribner describes two new grasses.

ANY SUGGESTION that may throw light upon the origin of the higher carbohydrates in plants from carbonic acid is welcome. Bach proposes[1] a hypothesis which has some experimental evidence to support it. It is founded upon a possible analogy with the decomposition of sulphurous acid in sunlight, thus: $3H_2SO_3=2H_2SO_4+H_2O+S$. Similarly: $3H_2CO_3=2H_2CO_4+\boxed{H_2O+C}$. The H_2O+C is formic aldehyde and the H_2CO_4 is supposed to decompose further, thus: $2H_2CO_4=2CO_2+2H_2O_2=2CO_2+2H_2O+O_2$. The experiments show the formation of CH_2O and of H_2CO_4. The rest of the process is hypothetical.

MR. ROSCOE POUND has translated and published in the *American Naturalist* (Feb.) Saccardo's paper at the Genoa Congress on "The Number of Plants." A chronological table is given, running from Hippocrates (500–400 B. C.), who reckons 234 plants, to the estimate of Duchartre (1885), who reckons 125,000 species, of which 100,000 are Phanerogams. By putting together all the recent monographs Saccardo reaches the following result, up to 1892: phanerogams 105,231; ferns 2,819; other pteridophytes 565; mosses 4,609; liverworts 3,041; lichens 5,600; fungi 39,603; algæ 12,178; total 173,706. The author then estimates the probable increase in the total, resulting chiefly from the rapid increase in our knowledge of the fungi, and thinks that we will not go astray in estimating that the flora of the world, when it is completely known, will consist of at least 385,000 species of plants, that is, 250,000 fungi and 135,000 of all other groups. It does seem that those who are describing fungi are rapidly verifying this prediction.

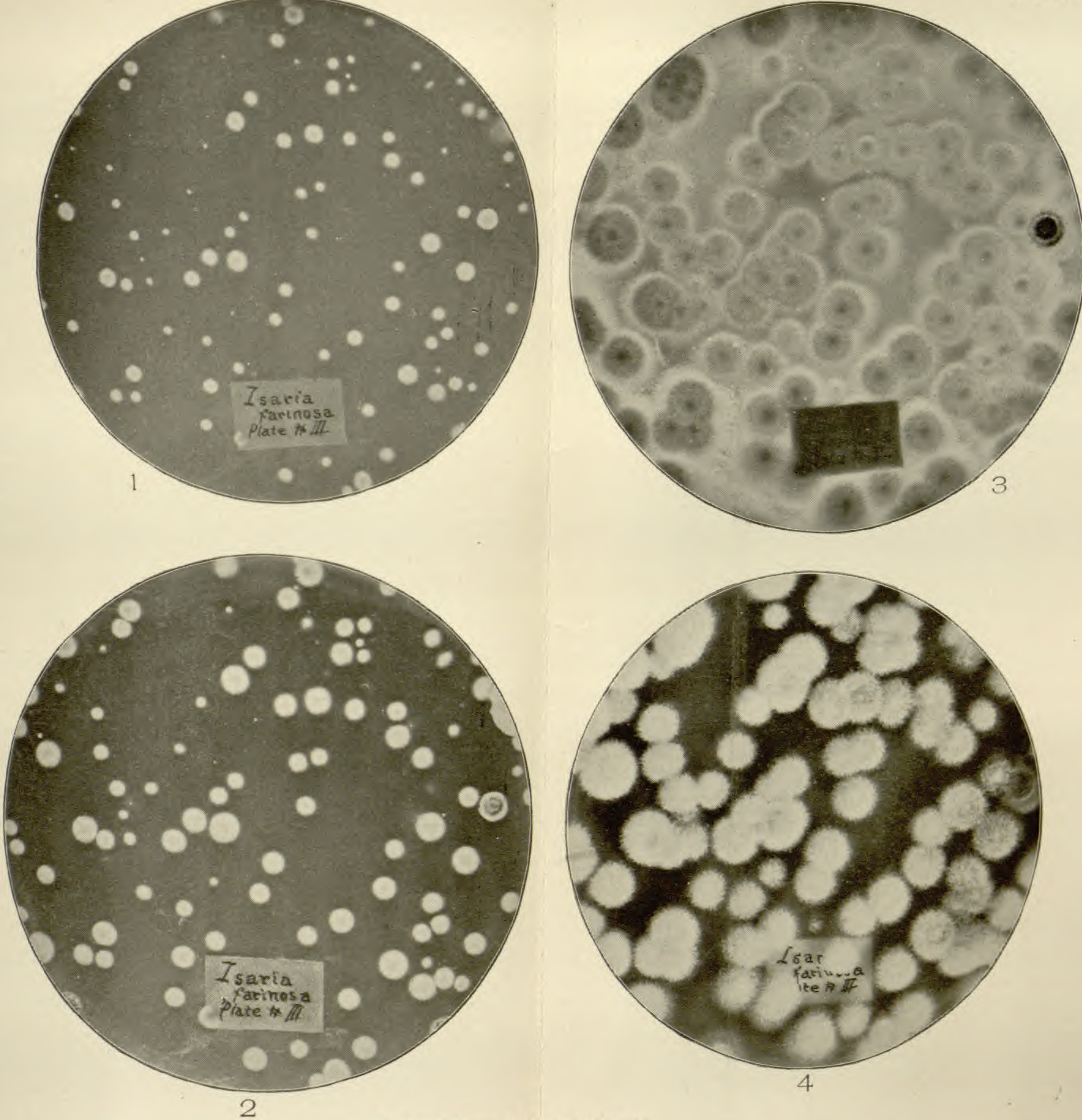
THE BOTANICAL SEMINAR of Washington, D. C., was organized last year, and at present consists of the following members: E. F. Smith, F. V. Coville, B. T. Galloway, Theo. Holm, G. H. Hicks, M. B. Waite, A. F. Woods, D. G. Fairchild, W. T. Swingle, and M. A. Carleton. The Seminar has for its objects, (1) the social intercourse of members; (2) the advancement of botanical knowledge by the presentation of original and other papers, and the free discussion and criticism of the same. The Seminar meets twice a month, at the residences of the members, the meetings, presentation of papers, and discussions being wholly informal. Papers on the following subjects have been recently presented and discussed: Anisophylly in Liquidambar, Sassafras, Vitis, and other plants, Holm; The Hexenbesens of Washington and vicinity, Waite; Some physiological factors influencing the growth of plants in greenhouses, Galloway; Root development in certain plants

[1] Compt. rend. Acad. Sci. Paris **116:** 1145, and 1389. 1893.

of the great plains, Coville; The downward water current in plants, Smith.

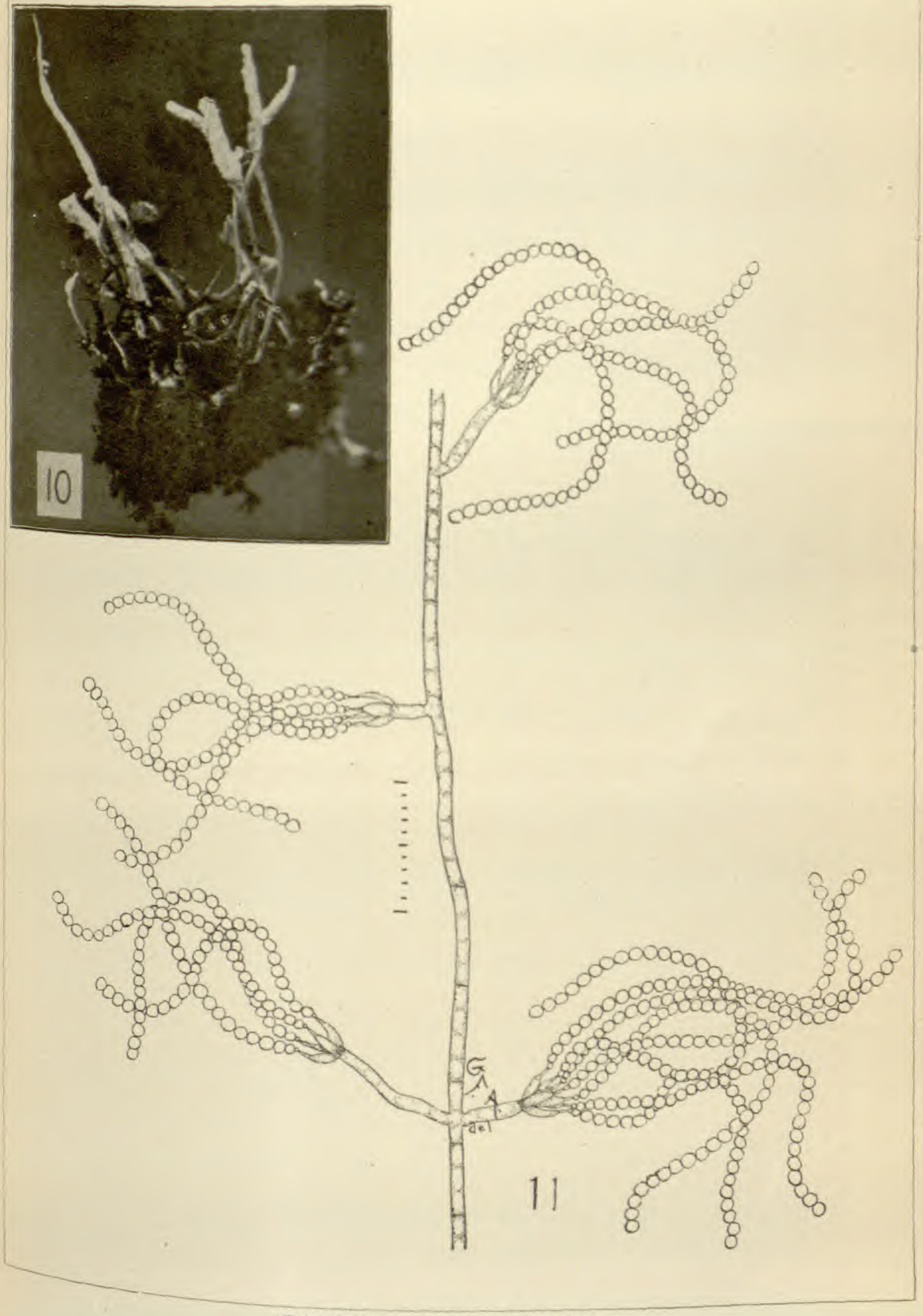
IN THE *Bull. de l'Herb. Boiss.* for February M. John Briquet, who has in preparation a monograph of the Labiatæ, discusses certain questions of nomenclature, chiefly in the light of Dr. Otto Kuntze's recent publications. His purpose is to reply to criticisms and to submit certain matters for consideration by the next international congress. He first considers the question of *nomina nuda* and *nomina seminuda*, rejecting the latter division as useless. To him a name is either valid or not valid, and he would reject any generic name not accompanied by a generic description, considering reference to included species, or exsiccatæ unaccompanied by descriptions, as not sufficient. The second subject is the point of departure for generic nomenclature, in which he scouts the date 1753 on the ground that the Species Plantarum contains no generic descriptions, and insists upon 1737. With considerable elaboration and illustration the status of Rumphius and P. Browne is discussed as to whether they may be considered authors of genera in the Linnæan sense. The so-called genera of Rumphius are declared invalid, as the illustrations seem to abundantly indicate; while those of P. Browne are found to be perfectly logical. In reference to the "once a synonym always a synonym" rule of the Rochester code, M. Briquet shows that it was already in the Paris code, though not so explicitly stated and commonly disregarded, and that "tout le monde doit l'appliquer rétroactivement." A section on the place of pre-Linnæan writings in nomenclature simply raises the point that this question represents a great hiatus in the Paris code, which should be definitely filled up, either by a special article, or by an explanatory note. The author says that pre-Linnæan authors must always be read in order to understand Linæaus, but it is evidently his opinion that they should not enter into nomenclature. The author also considers the question of the nomenclature of subdivisions of species. He regards the genuine variety, which he tries to define, as the only thing worth receiving a name from systematists, all minor subdivisions not being matters of systematic attention, but "biologically" interesting. In conclusion, amendments to the Paris code, embodying the ideas previously set forth, are formally proposed. Among them it is interesting to note the following: That priority of names and of combinations of names shall start from the following dates: 1703 (Ray, *Methodus emendata*), for all the grand subdivisions of the plant kingdom, such as dicotyledons and monocotyledons; 1737 (Linnæus, *Genera*, Ed. 1), for genera and their subdivisions; 1753 (Linnæus, *Species*, Ed. 1), for species and their subdivisions; 1789 (Ant. L. de Jussieu, *Genera*), for families and their subdivisions. The author demands that the next congress, which should be called soon, shall consider amendments to the Paris code "l'une après l'autre," and not vote "en bloc" for a whole scheme, as desired by Dr. Kuntze; and that the propositions to be considered singly are those of J. Müller Arg. (1874), Alph. DC. (1883), O. Kuntze (1891 and 1893), those "en partie singulières" of the American Congress at Madison (1893), and those presented in the present paper. Altogether the paper is a valuable contribution to the already voluminous discussion of nomenclature.

GOLDEN on AUXANOMETER.



ATKINSON on ISARIA FARINOSA.

ATKINSON on ISARIA FARINOSA.



ATKINSON on ISARIA FARINOSA.

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THE BOTANICAL GAZETTE

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[Entered at the Post-office at Madison, Wis., as second-class postal matter.]

In the June number will appear:

Leaf movement in Cercis Canadensis, by MR. S. G. WRIGHT, *La Fayette, Ind.*

New mosses of North America. V, by MM. F. RENAULD and JULES CARDOT, *Vesoul* and *Stenay, France.*

Notes on Richardia Africana, by MR. ERNEST WALKER, *New Albany, Ind.*

The influence of mechanical resistance on the development and life period of cells *will be concluded in the June number.*

BOTANICAL GAZETTE

MAY, 1894.

A study of Quercus Leana.[1]

E. J. HILL.

The oak known as *Quercus Leana* Nutt. is considered a hybrid of the shingle oak, *Q. imbricaria* Mx., and the scarlet oak, *Q. coccinea* Wang., the latter including the black oak, *Q. tinctoria* Bartram, as a variety. It has been sparingly found in the central states, and also near Washington in the east. The original tree, figured and described by Nuttall in his continuation of Michaux's Silva,[2] was detected about fifty years ago by T. G. Lea, near Cincinnati, O. Since then it has been found in several places in Illinois and Missouri by Dr. Mead, Dr. Engelmann, and others. In most of these localities but a single tree, or a couple of trees, were seen.[3] Some of these have since been destroyed. Like other hybrid oaks it is very rare, though more frequent perhaps than has been reported, since it is easily overlooked unless one is familiar with the varied characters of some of the biennial-fruited oaks, particularly the species with lobed leaves.

In the summer of 1890 I came across a form of this hybrid in greater numbers than have been reported elsewhere, and have observed them each season since. The locality is near Willow Springs, about fifteen miles southwest of Chicago. Eight or ten pretty clear cases of hybridity were at first made out, and some others noticed which seemed to show the effects of crossing, but were not distinct enough to be satisfactorily separated from the typical Q. imbricaria. Most of these trees have since been cut down, and last year but one remained, though stool shoots were starting from the stumps of some

[1] Forming part of a paper on "Natural Hybrids" read before the Chicago Academy of Sciences.

[2] l. c. 1: *pl.* 5 bis.

[3] Engelmann, Papers on American Oaks. Botanical Works, 405.

that had been removed, showing that the roots readily produce a coppice. Attention was first called to these trees by finding twigs torn off and scattered over the ground by a heavy storm of wind. Among them were some carrying leaves of an unfamiliar kind of oak, which were soon traced to the trees from which they came. The trees were mixed with others, mostly oaks represented in the hybrid, within an area of a couple of acres. The soil was of a gravelly nature, almost exclusively bearing oaks and hickories, with an undergrowth of hazel in the more open spaces. The hybrid trees were from fifty to sixty feet high, their bolls free from limbs for the first fifteen or twenty feet, except from the occasional presence of adventitious shoots. The largest tree was three feet nine inches in circumference at a foot and a half above the surface of the ground, just beyond the swelling occasioned by the roots. The rest were about a foot in diameter, so nearly of the same girth and height as to indicate that they were of about the same age. The outer bark could not be distinguished from that of the typical shingle oak of the same age and size, being but slightly furrowed, close and rather smooth, and of a dark gray color. The trunks did not have the black, rough and deeply furrowed bark so characteristic of the black oak even on small trees, for it begins to have this character quite early in life. A section of the bark showed essentially the same characteristics as that of the shingle oak, the inner bark being of a reddish or reddish-yellow color.

The leaves are from three to seven inches long, and one third as wide, on peduncles about an inch in length. They are somewhat pointed, and with a variable base, either acute, wedge-shaped, or rounded, sometimes approaching a cordate form, the broader leaves usually with a rounder or fuller base. The margin varies from forms slightly undulate to those irregularly sinuate-lobed to coarsely dentate-lobed. When lobed the segments are either rounded or acute, and when acute are triangular in form. The sharp lobes end in a bristle, and the adjoining sinuses are deeper and narrower than those in leaves with rounded lobes. In this lobation the influence of the black oak is seen, changing the form of leaves with an entire margin, characteristic of the shingle oak, to those approaching the less divided kinds of the black oak. The leaves on the stool shoots are larger, and are less divided than those on the trees. This is apt to be the case in the young growth of all the oaks. The lobes are acute, or blunt, most of them tipped with a bristle. Some leaves are pointed as on the trees, and others are broader at the apex, ending in three lobes, resembling those figured by Dr. Brendel from a hybrid oak, Q. Leana, near Peoria, Ill.[4] The leaves on the upper part of the trees showed a tendency to a deeper lobation than those on the lower limbs, especially than those on adventitious shoots of the trunk. The leaf surface is glossy, having about the same luster and color as that of the black and the scarlet oaks, but paler than in the shingle oak. In the mature leaves there is a trace of pubescence along the midrib and primary veins beneath. Young leaves, as well as those of the stool-shoots, are more or less rusty-pubescent, especially on the lower surface, about as much so as in Q. imbricaria. The margin of the leaves, particularly when young, is a little revolute, showing in this as well as in the pubescence the effects of the shingle oak. The winter buds are ovate, blunt three- to five-angled, larger than those of Q. imbricaria, but not so large or rusty-downy as those of Q. tinctoria. The hairs on the freshly started leaves are identical in structure with those of Q. imbricaria, being dense, matted, and curled or woolly, while those of the black and scarlet oaks are longer, coarser, straighter and scarcely matted. The bark of the young branches is greyish-brown, with numerous roundish gray and often warty lenticels raised above the surface. The color of the bark is like that of Q. imbricaria, but the lenticels are more prominent.

The perianth of the male flower is hairy, two- to four-parted, with thin, yellowish-brown segments; the stamens are four to five with large blunt anthers, on smooth filaments one-third to one-half their length. The acorns are roundish-ovate, half an inch long, with a short blunt or truncated knob at the top. The cup is saucer-shaped, covering about one-third of the nut; the scales of the cup are pubescent, blunt and appressed, occasionally a little squarrose near the margin of the cup. The acorns, especially when fresh, are often longitudinally striped with bands of a darker color, as in many of the black-oaks. They are somewhat larger than those of the shingle-oak, with a more prominent knob, that of the latter being but slightly raised or often quite flat or nearly obsolete, with a

[4] The American Entomologist and Botanist, **2**: 316. 1870.

flat areola at its base. In the black and the scarlet oak the knob is prominent, and more pointed and conical. The acorn-cup is flattish and abruptly contracted to the short peduncle as it is in the shingle oak, while in the black and the scarlet oaks it is more rounded and tapering below, sometimes in the scarlet oak being quite conical beneath. The acorns of nearly all specimens of Q. tinctoria growing in the vicinity of the hybrid were, so far as examined, considerably larger than those of the hybrid. Their cup-scales were very pubescent, and almost always with wavy, squarrose tips. The meat of the acorns was intensely bitter, from a light to a deep yellow or orange color, not white or pale as is generally the case with the scarlet oak. The interior of the cup was yellow. The meat of the acorns of the hybrid was of a pale yellow color and was very bitter in taste. By the character of the fruit, the color of the outer bark and the rich yellowish-brown or russet tinge of the autumn leaves, the neighboring biennial-fruited oaks had the characteristics of Q. tinctoria. But the leaves were usually deeply lobed, and the inner bark, though generally yellow, was sometimes reddish as in the scarlet oak. From all indications, the hybrid seemed to be a cross of Q. tinctoria and Q. imbricaria. But the characteristics of Q. tinctoria and Q. coccinea sometimes blend so far as to make it difficult to separate them, though from careful study of the various forms I believe them to be distinct. If, as many do, we regard Q. tinctoria of Bartram a variety of Q. coccinea of Wangenheim, then the hybrids at Willow Spings would be a cross derived from the variety, not the type.

Quercus rubra occurred not far away in the same piece of woods, but no signs of hybridism were seen between the red oak and the shingle oaks in its vicinity. These were not scattered throughout the woods, but were frequent only where the hybrids were found. Two annual-fruited species, Q. alba and Q. macrocarpa, were the only other kinds observed, but such seem out of the question for parentage.

The hybrids differed somewhat from the published descriptions of Q. Leana which I have seen, combining most of the characteristics of the individual cases described from other localities. The number of trees offered a greater range for showing the influence of the double parentage. But it was quite easy to match the leaves with those which I examined in the large collection of the Engelmann herbarium, now in the Missouri Botanic Garden at St. Louis. They do not differ materially from authenticated specimens from the original tree at Cincinnati, nor from those figured by Nuttall. As Dr. Engelmann did not specifically separate Q. tinctoria from Q. coccinea, there is no way to determine which of the two he regarded as most effective on the hybrid. He says of the hybrid: "The relationship to *imbricaria* is unquestionable, and among the lobed-leaved black oaks we must look to one of the forms of *coccinea* for the other parent, as the acorns, and especially the cup and scales, indicate." Of one growing in St. Clair county, Ill., twenty miles from St. Louis, and of which Q. rubra was at first thought to be one of the parents, he says: "The cup of the acorn is to me decisive. It is turbinate, covered with rather large canescent scales, squarrose at the tip, and very different from either *rubra* or *imbricaria*, but approaching those of *coccinea*. The globose acorn, seven lines in diameter, one-third covered by the cup, shows twenty-two to twenty-five black stripes, so common in many black-oaks."[5]

No seedlings of the hybrid were detected. Those of any of the oaks were scarce, since the wood was a pasture for horses and cattle, though not so closely pastured as to prevent a considerable undergrowth of shrubs. But it is probable that the hybrids, or some of them, considering their number, came from acorns. There is no apparent defect in the nuts, which are as plump and are produced as abundantly as those of other oaks in the vicinity. Dr. Engelmann has also noticed the scarcity of seedlings of hybrid oaks, and remarks upon it: "All of the supposed hybrids are abundantly fertile, and those of their acorns which have been tested have well germinated; in fact, as far as I know, no difference in fertility between them and the acknowledged species has been discovered. The seedlings of such questionable individuals do not seem to revert to a supposed parent, but 'come true,' as the nurserymen express it. For how many generations this may continue, and whether in time forms approaching one or the other parent may not appear, remains to be seen. At the same time it is a remarkable fact, that notwithstanding their fertility they do not seem to propagate in their natural woods. We may, perhaps, ascribe this to a lesser degree of vitality in the hybrid progeny which causes them to be crowded

[5] Botanical Works, 406.

out in the struggle for existence; one of the provisions of nature to keep the species distinct; or, as Dr. Gray suggests, fertilization by one of the parents may soon extinguish the hybrid characters."[6]

To those who question the hybridity of these oaks, and deem such forms varieties of closely related but very variable species, the answer may be made that, since hybridizing is a frequent resort of the horticulturist for the production of new varieties of plants, it is to be expected that something of the same kind will occur in nature where plants nearly related grow together promiscuously. As such crosses are effected by dusting the stigma of one species or variety with the pollen of another species or variety of the same genus, or in the case of bigeneric hybrids, of a different genus, similar results may be looked for among wild plants where this dusting must often occur whether effective or not. But it is in the highest degree efficient for plants of the same species to be cross-fertilized, and in many cases it is the sole method of fertility. It is done on so large a scale by various agencies that our surprise should not be at finding spontaneous hybrids, but that they are seemingly so rare in wild plants. Failure to produce them has to be ascribed to other causes than the lack of opportunity. And it is in genera with diœcious, and often anemophilous, flowers, such as Carex, Quercus and Salix, that hybrids have most frequently been detected in nature. Especially is this the case with willows.[7] With such genera the conditions are least complex, and the opportunities for hybridizing most frequent.

These oaks plainly show the marks of hybridism such as have been noted by various observers, and summarized by Sachs, among which the two following closely apply: (*a*) "The hybrid is possessed of external characters intermediate between those of its parent forms, usually nearly half way between. (*b*) The characteristics of the parent-forms are as a rule so transmitted to the hybrid that the influence of both is manifested in all its characters, producing a fusion of the different peculiarities."[8]

It is also very strongly in favor of their hybridity for these

[6]Botanical Works, 403.

[7]Insects, especially bees, take an active part in the pollination of willows. Wimmer, Salices Europaeae, Introduction, p. *xlviii*. Ib. Wildwachsende Bastardpflanzen, 144.

[8]Lehrbuch (4th ed.) 891. Text Book, 917.

oaks to occur only where the shingle oak is found. Having frequently and extensively traversed the woodlands in the vicinity of Chicago, and carefully examined the oaks of different localities, since they are the prevailing trees, I have only seen this form where we first meet with the shingle oak, which comes up the valley of the Desplaines as far north as Willow Springs, at least. It is on the border of the northern limits of the species in this vicinity, for it becomes a common tree only to the south. Immediately east and south in the sandy region by the head of Lake Michigan the black oak is the prevailing species, probably ten times as numerous as the other biennial-fruited oaks taken together. But leaves of the peculiar form shown by the hybrid have been detected nowhere else. There are plenty of transitions in leaf-forms between the black and the scarlet oak, and to some extent between these and the red oak, but none between them and the shingle oak except where Q. imbricaria was first encountered, for both the species and the hybrid were found the first time of visiting the locality. Though the proof from proximity may not be conclusive, when it is taken in connection with the blended characteristics of the form, it is hard to resist the conviction that the parentage was specifically double, and that the parent-forms are those whose characters are most evident in the offspring.

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Contributions to the histology of the Pontederiaceæ.

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WITH PLATE XVII.

Comparatively little work has been done on the histology of the Pontederiaceæ. The roots have been studied somewhat in a comparative way by M. Treub, L. Morot, F. Hildebrand, S. Schönland, and others. A comprehensive study of the anatomy of water-plants was begun by F. Parlatore, but death prevented the completion of the work. Nine plates, however, were published in 1881. These contain among the drawings of about ninety species of water-plants a few very diagrammatic drawings of two species of Pontederia. No explanation accompanies the plates.

Solms-Laubach has a monograph of the Pontederiaceæ in A. et C. de Candolle's Monographiæ Phanerogamarum; but a short review of this[1] shows that it is systematic rather than histological. J. Duval Jouve, in 1873, investigated the diaphragms, or cross-plates, in the air-cavities of Pontederia cordata. E. M. Wilcox, in the *Journal* of the Cincinnati Soc. of Nat. Hist., July–Oct., 1893, has noted a few points in the histology of the same species.

In the botanical laboratories of Wabash College, some studies were made in the spring of 1893 upon the histology of Pontederia crassipes, a cultivated form, and since then a comparative study of all the available members of the order was undertaken and types of other aquatic plants examined. The Pontederiaceæ are aquatic herbs, growing in mud, or shallow water. There are two genera embracing four species in our northern United States flora, all but one species of which (Heteranthera limosa) are reported in our Indiana flora.[2] All the four species have been studied, as well as the cultivated Pontederia. In the world's flora there are reported twenty-three species and six genera[3] grouped under this order, principally tropical in their habitat.

Pontederia crassipes Mart. (see fig. 1) is an interesting cultivated aquatic, growing rapidly in a basin or vessel of

[1] Botanischer Jahresbericht **11**: 622. 1883.
[2] Bot. Gaz., **6**: Supplement. 1881.
[3] MacMillan, Metaspermæ of Minn. Valley. 1892.

water and spreading over the surface by means of off-shoots. It has a thick root-stock, and long roots with very many lateral rootlets, so that a light feathery appearance is given to the whole. The roots are colored a dark violet-blue. F. Hildebrand suggests that the probable biological reason for this is to provide immunity from living animals in the water by making the roots less visible to them.

A striking peculiarity is the *thick petiole* of the leaf. The lower portion is expanded into a resemblance to a pseudobulb, which serves to float the plant. The flowers of P. crassipes, as well as of *P. cordata* L., are violet blue and ephemeral. P. cordata, also, has a thick root-stock. It produces erect long-petioled mostly heart-shaped leaves, and a stem with a single leaf bearing the spike of flowers.[4]

The three species of Heteranthera, *H. reniformis* Ruiz & Pav., *H. limosa* Vahl., and *H. graminea* Vahl. are "creeping, floating, or submerged low herbs, in mud or shallow water, with a 1–few-flowered spathe bursting from the sheathing side or base of a petiole."[5]

The parts for sectioning were hardened 24–48 hours in a dehydrating apparatus and afterward imbedded in collodion. Great difficulty was experienced in infiltrating thoroughly with collodion the parts of P. crassipes above the water, the stem, leaf, etc., presumably on account of the floating tissues being so repellent to liquids. Especially was this difficulty found with every part of the leaf tissues, parts of which were cutinized. The loose aerating tissues of the root present no such difficulty, nor do any of the tissues of the other species. Most interesting points in the histology of this order were brought out.

The root of P. crassipes presents a beautiful structure. The cap is very large and is organically connected with the very tip of the root only, being free at its upper end (fig. 3). Goodale[6] says that this sort of a cap occurs in several species of Pontederia, and envelops the root for the length of half a centimeter. The caps of P. crassipes, however, enveloped the largest roots for 2.5^{cm} or even more. A median longisection of the root-tip shows well the connection of the cap as well as the structure of the tip itself. Hæmatoxylin

[4]Gray's Manual, 536.
[5]Gray's Manual, 536.
[6]Physiological Bot., 108.

brought out a marked differentiation just without the central cylinder, in the pericambium. At regular intervals, certain small groups of cells peripheral to the central cylinder stained a much darker blue than the surrounding cells. From their position it was judged these were the nascent tissues of the lateral rootlets, the darker staining indicating their greater activity. The mode of formation and development of the lateral roots from the mother root can be easily followed. Longisections of the rootlet coming off from various sections of the root were secured. These show the rootlet branching from the pericambium and organically connected with the central cylinder only, for a space surrounds it and separates it from the endodermis, cortex and epidermis.

Back from the tip at varying distances in different roots of the same length, but averaging about 1.5^{cm}, were noticed the beginnings of the large air-cavities. A cross-section shows the plerome cylinder surrounded by a sheath of thin-walled cells. Just without this endodermis are about six or seven rows of very regular cylindrical cells (fig. 2) forming loose tissue, with large intercellular spaces. Outside of these, between the cells of the cortex proper, occur the radiating air-cavities of varying width, traversing the length of the root.

The coloring matter of the root and root-stock, anthocyanin, imparts a dark-blue color, except for an inch or more back of the tip. It is in solution in the cell-sap of the epidermal cells only; is soluble in alcohol and is turned red by dilute acids.

The running stem bears an off-shoot at its distal end. It has aerating spaces particularly large and abundant near its periphery. The closed collateral bundles are but few in this loose region. By far the greater number are aggregated in the center of the stem, forming in mass a cylinder. The root-stock has a structure somewhat similar to that of the stem. Bundles of raphides are very abundant, especially toward the periphery, outside of the cylindrical aggregation of bundles. There was no evidence of starch being stored in the root-stock.

The leaf shows perhaps the most interesting histological structure. When the inflated petiole is cut through, large hexagonal cavities $0.5–2^{mm}$ in diameter are seen (fig. 4). The shining cutinized partitions are plainly visible. This loose tissue is almost impervious to water. A section placed in water shows a great deal of air imprisoned in the cavities. This inflated petiole refused to be infiltrated.

The cross-partitions, or diaphragms, are horizontal or oblique and are composed of polygonal cells, with interstitial air-spaces at the angles leading from one chamber to another. The cell walls in some of the partitions are very thick. According to De Bary[7] "air-passages in internodes, petioles, and leaves of most monocots are partitioned by diaphragms," or "stellate tissue," as it is frequently called. De Bary furthermore makes the general statement that Pontederia has diaphragms composed of many-armed cells "forming a plate with wide lacunæ." In the plates of P. crassipes, "interstitial spaces" is the more correct term for the openings between the cells, because they are of much smaller volume than the surrounding cells. True lacunar cavities occur in the diaphragms of P. cordata, however, while those of Heteranthera limosa and H. reniformis are small like those of P. crassipes. The cells of the diaphragm each have well-defined nuclei and granular protoplasmic contents, with a few starch grains. These diaphragms probably serve several purposes. Duval Jouve suggests that besides the function of allowing the passage of air, they have the office of support points for the *cross-running*[8] fibrovascular bundles. No transverse bundles, however, were noticed in P. crassipes, while in P. cordata, only in a few of the cross-plates of the smaller peripheral passages do they occur, those of the central cavity being free from them. Probably one of their principal functions is to support the surrounding parenchyma tissue and to prevent the air-passages from collapsing.

A cross section of the leaf of P. crassipes shows how admirably lightness is secured. A large air-passage usually accompanies each bundle, traversing the leaf side by side with the latter. Stomates are abundant on both sides of the leaves and on the petioles of all the species except Heteranthera graminea, the latter being submerged. The epidermal cells of each are somewhat thin-walled with the exception of those of P. cordata, which have minute tubercles on their outer walls.

The closed vascular bundles are very similar in all the species. They are surrounded usually by one layer of parenchyma cells with a large amount of bast in the phloëm and a few sclerenchyma cells opposite. Mr. Wilcox says that

[7] Comp. Anat., 217.
[8] Review in Bot. Jahres. 1: 196.

there are in P. cordata "peculiar starch cells" on each side of the fibro-vascular bundle. The "specialized cells," as he further designates them, were noticed in the petiole and leaf-bundles of P. crassipes just without the xylem portion of the bundle on either side, also an abundance of grains was seen in the larger parenchyma cells of the sheath proper (see fig. 4.). Also in P. cordata these cells were noted, with little starch or none in the larger cells surrounding. Sachs[9] says that "the reservoirs of reserve materials or organs of assimilation . . . are chiefly in that layer of parenchyma which immediately surrounds the vascular bundle." This Sachs long ago introduced into physiology as the "endodermis" and called it the "starch-bearing layer." As these "specialized cells" are part of the parenchyma cells of the "starch-bearing layer" of Sachs, one is hardly justified in designating these cells "peculiar starch cells," when their presence is the rule in all bundles. In Heteranthera limosa starch is very abundant in stem, petiole, and leaf, particularly in the parenchyma bundle sheath and the loose cells immediately about the bundle on both sides of the xylem, also in the cells of the diaphragms.

These conditions illustrate an important physiological fact, that the store-houses of food are near the highways, where it is most easily accessible. The distribution of reserve food in aquatics and the arrangement of the aerating organs is a subject of great importance. A comprehensive view of the varying conditions in aquatic plants will throw a great deal of light upon many interesting physiological problems in the life history and development of these interesting groups of plants.

In the diaphragms of P. cordata and P. crassipes are found crystal sacs containing raphides, projecting upward or downward into the cavities. Besides there are other sacs of a spindle-like shape (fig. 5.), with their longer axes placed at right angles to the diaphragm and with their middle inserted in it, so that the ends project upward and downward into the space. Each of these contains a spear-like crystal of calcium oxalate, pointed at both ends. In P. crassipes, this long kind of crystal is not so abundant in the cross-plates examined. In P. cordata, the sac attains a length of more than three times the thickness of the diaphragm. De Bary[10]

[9]Physiology, 358.
[10]Comparative Anatomy, 220.

refers to Meyen for authority for the statement that the "membrane of the sac covering the ends of the crystal ceases to be apparent, so that the latter seems to protrude freely into the air-space." None in the diaphragms of the P. cordata studied presented this phenomenon. On the contrary, it was found that all were in thick-walled sacs. In all probability, the unusual thickness of the walls partly explains the long resistance to the action of acids. Concentrated HCl applied to the section of the diaphragm slowly dissolves the raphides in one to two minutes, while the lance-shaped crystals were not completely dissolved for 1½ hours or more, leaving the thick wall of the sac but slightly shrunken. In Heteranthera limosa, no long crystals were observed. There was, however, an abundance of raphides, especially in the small peripheral cavities of the petiole.

There was also present in most of the cross-plates of all the five species, but most abundant in P. cordata, a reddish-brown secretion in ellipsoid or dumb-bell shaped cells with very thick walls, scattered in few numbers among the stellate cells (figs. 5 and 6). Ether acts very slowly on this secretion. Preliminary experiments led to the belief that it was a gum. But, in 24–48 hours, the section left in ether showed a yellowish-brown color in the cells immediately surrounding the ellipsoidal cell, intimating the slow dissolution of the contents. Benzine acted much more rapidly in its dissolution. In all probability, the substance is a *fatty oil*, though there is room for doubt.

Among the upper row of long palisade cells of the leaf of P. cordata are many others of similar shape containing a yellowish secretion (fig. 7). These are somewhat regularly placed between the many stomates, as can be seen in a thin tangential section. Probably also in P. crassipes and H. graminea, this substance occurs sparingly. Nothing was positively determined as to its composition.

In the older stellate tissue of P. cordata, a marked peculiarity was noticed in the walls where the arms of adjoining cells met. Under high power frequently were seen one to a half dozen or more breaks in the thick wall which separates the two cells (fig. 6). In cross section, small pits were observed piercing a narrow partition. In testing for cellulose walls, concentrated sulphuric acid shrunk the protoplasm in the stellate cells, in some leaving a fine shrunken thread running from the mass into each ray of the cell. In many cases the thread held fast through the pore to that of the adjoining cell—a beautiful exposition of continuity of protoplasm.

The presence of active nuclei in the cells of the diaphragm and of starch in some, and the continuity of the protoplasm in the cells, is suggestive of these cross-plates serving a far more important function than the mere mechanical one of support. These facts indicate rather a close connection with the centers of vital activity in the plant.

New light may be thrown by such a suggestion upon the presence and regular occurrence of diaphragms in this group of plants. Some physiological experiments may further point out the real functions. It is expected that a careful study will be made of the structure of plants of allied groups and the true relationships of aquatics sought.

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EXPLANATION OF PLATE XVII.

Fig. 1. A young plant of P. crassipes, showing an off-shoot. ×¼.—Fig. 2. Transection of root of P. crassipes. ×140.—Fig. 3. Longisection of root-tip of P. crassipes, showing cap and origin of lateral rootlets. ×55.—Fig. 4. Transection of inflated petiole of P. crassipes; *a*, diaphragm, with starch in the cells; *b*, starch grains in bundle sheath. ×55.—Fig. 5. Transection of a diaphragm of P. cordata; *a*, side partition of air-cavity, showing the attachment of the diaphragm; *b*, a spindle-shaped crystal in its sac; *c*, a bundle of raphides; *d*, two pits in the wall between two cells; *e*, a secretion of a fatty oil, showing manner of insertion among the cells of the diaphragm. ×350.—Fig. 6. Surface view of a portion of a diaphragm of P. cordata: *a*, an air-passage; *b*, a pit in the wall separating two cells; *c*, cell containing fatty oil. ×350.—Fig. 7. Transection of leaf of P. cordata. Upper portion of the section, showing the large cells among the palisade cells, the former filled with some secretion. ×350.

Notes on Ustilagineæ.

WILLIAM ALBERT SETCHELL.

WITH PLATE XVIII.

DOASSANSIA OPACA Setchell occurs on *Sagittaria variabilis* at Providence, R. I., and at New Haven, Conn.

D. OCCULTA (Hoffm.) Cornu has been collected on *Potamogeton Claytonii* at Cold Spring Harbor, N. Y., by Mr. Thomas Morong and at Bridgeport, Conn., by the writer.

D. MARTIANOFFIANA (Thuem.) Schrœter has been found growing on the leaves of species of Potamogeton in Marl pond, Courtland county, N. Y., by Prof. C. H. Peck and in great abundance by the writer in Twin lakes, Salisbury, Conn., in a pool near North Haven, Conn., and in lake Whitney near New Haven, Conn. The species of Potamogeton have not been carefully determined for these specimens but they were certainly not *P. Claytonii* in any case.

The occurrence of D. Martianoffiana as a probably not uncommon American species is assured by these discoveries and it is to be hoped that the germination of the spores may be observed and its relationship to D. occulta more satisfactorily determined. As far as the information at present is concerned there seems to be good reason for still keeping it distinct from D. occulta. The two species have in common the structure of the sorus and similar host-plants. I have, however, never found them either upon the same species of Potamogeton or in the same locality. The presence of conidia in D. Martianoffiana as shown by Prof. Peck's specimens, as well as the difference in habit, also point towards a distinction between the two.

D. DEFORMANS Setchell has proved to be of rather wide distribution in the United States. It has been collected in Missouri by Rev. C. H. Demetrio and in South Dakota by Mr. T. A. Williams. For specimens from these localities I am indebted to the kindness of Dr. O. Pazschke and Prof. W. G. Farlow. I have also collected it near Providence, R. I., and New Haven, Conn.

Doassansia intermedia, sp. nov. — Spot inconspicuous, light-yellow to brownish, circular, one-fourth to one-half inch in diameter. Sori hypophyllous, in the spongy parenchyma of the leaf-blade, decidedly ellipsoidal, 200–260μ long and 120–160μ thick. Outer covering of two or three layers of semigelatinized hyphæ usually present at maturity. Cells of the cortex more or less flattened, sometimes closely crowded together, sometimes more loosely placed with moderately thick brown walls. Spores globular, or nearly so, 6–8μ in diameter, in several irregular layers just underneath the cortex, not readily separable by crushing. Germination? Central portion of the cortex made up of thin-walled parenchymatous cells almost destitute of solid contents.

On leaves of *Sagittaria variabilis*. Shelburne, N. H., *W. G. Farlow!* Port Arthur, Minn., *F. W. Dewart!* August to October.

D. intermedia is the sixth member of the Doassansia group and the fifth of the genus to be found upon Sagittaria variabilis. In structure of the sorus it comes very near to the species of the subgenus *Doassansiopsis;* but instead of the spores being situated in a single regular layer underneath the cortex as they are in D. occulta, D. Martianoffiana, and D. deformans, in D. intermedia they are in several (2–5) irregular layers. Consequently it seems best to emend the character of the subgenus as follows:

DOASSANSIOPSIS.—Central portion of the sorus consisting of parenchymatous cells. Spores in one or more layers, inseparable at maturity. Cortex distinct.

D. intermedia also resembles *Burrillia pustulata* Setchell very much in general habit and structure but differs from it in the possession of a distinct cortex.

D. PUNCTIFORMIS Winter.—Niessl gave the name *Protomyces punctiformis* in 1872 to a fungus on *Butomus umbellatus.*[1] Schrœter referred Niessl's plant to the genus Doassansia as *D. punctiformis* in 1887.[2] In the meantime Winter[3] had bestowed the name *D. punctiformis* upon an Australian species inhabiting the leaves of *Lythrum hyssopifolia.* De Toni in his review of the genus[4] names *Protomyces punctiformis* Niessl, *D. Niesslii* and retains the name D. punctiformis for Winter's species. Magnus has recently[5] proposed the

[1] Verhandl. d. Naturf. Ver. i. Brünn, **10**:—.
[2] Pilzfl. Schles., 287.
[3] Rev. Myc., 207. 1886.
[4] Journ. Myc., **4**: 17, 1888 and in Saccardo, Syll. Fung. **7**: 505. 1888.
[5] Abhandl. d. Botan. Ver. d. Prov. Brandenburg, **32**: 253. 1890.

name *D. Winteriana* for the *D. punctiformis* Winter, deciding to retain Schrœter's name for *Protomyces punctiformis* Niessl.

The writer, however, has shown[6] that *Protomyces punctiformis* Niessl is not a Doassansia since the sori lack the cortex which Cornu considered the distinguishing mark of the genus, but that it is to be referred to the genus Entyloma. Consequently, the name *Doassansia punctiformis* belongs to the Australian species, of which, as Prof. Magnus kindly informs me, there is no specimen in Winter's herbarium. This prevents determining accurately whether *D. punctiformis* Winter, in turn, is a true Doassansia or not.

D. GOSSYPII Lagerheim.—Through the kindness of Prof. Lagerheim the writer has been able to examine specimens of this species. The sori occur in the spongy parenchyma of the leaf and are at first globular and wholly immersed. This is apparently the state seen by Prof. Lagerheim. Later however the sori break through the epidermis, the coating of hyphæ bursts open, and the spores are seen to be arranged in vertical rows, supported below upon sterile cells. The structure is not that of a Doassansia but more like that of some species of rust. The species may be referred provisionally to the genus Chrysomyxa, as **Chrysomyxa Gossypii** (Lagerh.).

CORNUELLA LEMNÆ Setchell has been detected by the writer at Providence, R. I. and New Haven, Conn. A careful search among the dying fronds of Spirodela will probably show that it is a widely distributed species.

ENTYLOMA COMPOSITARUM Farlow was found by the writer, growing in abundance on *Aster Novi-Belgii* at Peaks Island, Maine, in October, 1889.

The spores from the fresh material germinated readily in water and gave rise to promycelia 12–17μ in length and about 2.5μ in diameter. Each promycelium produced three, four or five sporidia, which were about 15μ long, of almost equal diameter (about 2μ) throughout their length, and blunt at each end. The sporidia produced germ tubes without falling from the promycelia. No conjugation was observed but such conditions as that shown in figure 8 seem to indicate that it takes place. Spores sown from dried material in late October and in November failed to germinate.

ENTYLOMA CRASTOPHILUM Sacc. is the species to which

[6] Annals of Botany, **6**: 38. 1892.

the *Ustilago lineata* Cke. is referred at present. It is a very common form near New Haven, upon the leaves of *Zizania aquatica*. The spores are dark and form elongated sori in the leaf tissue. They germinated rather freely when sown in water in May, 1892. The promycelium reached a length of from 25μ to 80μ. The sporidia were usually four in number. They do not seem to conjugate but produce buds from the distal end both before and after falling from the promycelia.

RHAMPHOSPORA NYMPHÆÆ Cunningham is described as occurring in leaves of different species of *Nymphæa* in India. What appears to be exactly the same thing has been found by the writer growing in leaves of *Nuphar advena* near New Haven, Conn., and in leaves of *Nymphæa odorata* at Ledyard, Conn., and at Woods Holl, Mass. Sowings were made in water both from fresh and from dried material but were unsuccessful.

Cunningham[7] separates this species from the genus Entyloma and makes it the type of the new genus Rhamphospora, because all the spores are borne at the tips of hyphal branches and because the promycelium is subverticillately branched.

A comparison between Cunningham's figures[8] and those of the germination of the spores of *Entyloma Magnusii* as figured by Woronin[9] and that of the spores of *Doassansia obscura* as given by the writer[10] will show that the "branches" of the promycelium are indeed primary sporidia and the fact that they do not conjugate, while the bodies produced from them do, is hardly sufficient for classifying them as peculiar structures. In many of the species of Entyloma and Doassansia the primary sporidia do not conjugate, yet there is no reason for considering them to be promycelial branches, for they arise in exactly the same way that the primary sporidia which conjugate do. The fact that these "promycelial branches" are finally septate is not in the way of their being considered primary sporidia, for the primary sporidia of many species of Entyloma and Doassansia are finally septate. The regular conjugation between what Cunningham calls the primary sporidia is peculiar but hardly sufficiently characteristic to be regarded as a generic rather than a specific distinction.

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[7]Scientif. Mem. of the Med. Officers of the Army of India, *3*. 32. 1888.
[8]Loc. cit. *pl. 2. figs. 7–16.*
[9]Beitr. z. Kenntn. d Ustilagineen, *pl. 4, figs. 24–26.*
[10]Annals of Botany **6:** *pl. 1. figs. 37–42.*

The development of the spores has not been studied very carefully in any species of Entyloma, yet it is known that in some species at least they are subterminal as well as intercalary. Consequently, it seems best to regard this form as **Entyloma Nymphææ** (Cunningham) rather than as the type of a distinct genus.

The common barnyard grass is the host-plant of two pulverulent smuts, the one *Tolyposporium bullatum* Schrœter, the other *Ustilago sphærogena* Burrill. The distortions produced by these two species are very similar in shape and size and I was much interested to find both of them in the same locality at Woodmont, near New Haven, Conn., and even in the same inflorescence.

TOLYPOSPORIUM BULLATUM Schrœter inhabits the ovaries of *Panicum Crus-galli* causing them to swell to several times their normal size. The surface of the swollen ovary is smooth and shining and the Tolyposporium may thus readily be told from the Ustilago on the same host. It is, therefore, not a very conspicuous species, but is apparently fairly common in the New England states. The spores are agglomerated into balls and germinate readily in water at almost any season. A longer or shorter promycelium is produced and from this, sporidia bud off either terminally or laterally. Secondary sporidia are produced from these, tertiary are produced in turn, and so on until very complex branching forms result. The type of germination is of the Ustilago- as opposed to the Tilletia-group, but the germination of Tolyposporium bullatum differs very decidedly in its details from that of *T. Junci* as Woronin represents it.[11]

USTILAGO SPHÆROGENA Burrill causes distortions of the spikelets of *Panicum Crus-galli* which in size and shape closely resemble those produced by the preceding species. The more luxuriant specimens, however, reach a somewhat greater size than those of the Tolyposporium and the surface of the distortion, instead of being smooth and shining, is rough, with short, rigid hairs. This is accounted for by the fact that the upper glumes and palets as well as the ovary are infected and distorted by the fungus.

The spores are free and germinate readily on being sown in water on a slide. Sometimes sporidia were produced when the promycelium has reached a length of a few micromilli-

[11] loc. cit. *pl. 4, figs. 5–8.*

meters but often the promycelium reaches a length of from 48μ to 50μ before sporidia are produced. The promycelia grow obliquely up toward the surface of the water on the slide and some of the sporidia project above the surface into the air. On looking down upon a slide covered with germinating spores, these projecting sporidia form perfect thickets. The chains of sporidia readily fall to pieces and continue to bud until the whole slide is covered with yeast-like cells.

Germinations were obtained from sowings made in February, May and October.

Yale University, New Haven, Conn.

EXPLANATION OF PLATE XVIII.

Fig. 1. *Doassansia intermedia* sp. nov. Portion of a median section through a sorus. × 700.—Figs. 2, 3, and 4. *Tolyposporium bullatum* Schrœter. Promycelia and sporidia. × 1000.—Figs. 5, 6 and 7. *Ustilago sphærogena* Burrill. Promycelia and sporidia. The dotted line in fig. 6 represents the surface of the water. × 1000.—Fig. 8. *Entyloma Compositarum* Farlow. Promycelium with sporidia producing germ-tubes. × 1000.

The influence of mechanical resistance on the development and life period of cells.

FREDERICK C. NEWCOMBE.

(Continued from page 157.)

3. *On differentiation in the fibrovascular bundle.*—It has already been pointed out (p. 154) that the effect of mechanical resistance to extension in the tissue adjoining the growing point is to delay the differentiation of that homogenous tissue into heterogeneous. It is also true that the same cause will delay the later changes which take place normally in the primary bundles by which some of their elements are developed into mechanical xylem and phloem.

Many young stems of various species of plants have received casts about internodes at such a time that the primary differentiation of tissue had proceeded so far as to mark off fascicular from fundamental, and such internodes in their subsequent growth have fallen far behind the neighboring free parts of the stem in progressive changes in the bundles; and it must be emphasized that this delay in development is not due merely to the fact that change could not take place because no cells were formed to undergo change. It will be seen that the cells already present before casting have within the casts retained their weak condition much longer than corresponding ones beyond the limits of the cast. Vicia faba has in all cases thickened none of the xylem parenchyma cells of the primary bundles within casts and formed no secondary tissue at the time when beyond the limits of the casts not only these primary elements had been thickened but a secondary zone of mechanical xylem ten to twelve cells wide had arisen. In Althaea tauriensis every bundle outside the limits of the casts develops many thick-walled cells before one appears in the bundles within the casts. Archangelica sativa and Myrrhis odorata thicken the elements in their primary bundles and form a wide band of thick-walled secondary xylem in normal parts of their stems before a thick-walled element appears in any bundle in the part of the stem confined by gypsum. A typical preparation of this plant serves also to show the effect of the confining cast on the thickening of the walls of vessels: an average bundle within the cast had in a radial row twelve thick-walled vessels, twenty-eight thin-walled; above the cast in the same stem in an average bundle the thick-walled vessels were forty, the thin-walled twelve. A shoot of Sambucus nigra that had grown for several weeks with a cast around one of its internodes had when examined a secondary zone of cells within the cast as well as out of it. Within the cast and a little above the cast the number of cells in a radial row of this zone was eighteen, the same in each case. But in the former only three cells had thick walls, while in the latter there were six such. Similar results to the foregoing were obtained in Urtica dioica, Dahlia variabilis and Forsythia viridissima. No contrary effect was obtained in any plant.

In experimenting on the effect of pressure on the development of thin-walled phloem into hard bast the results will perhaps be more striking, since in the plants selected the hard bast is of primary origin and the casts were not applied till the very cells destined for the fibres were present in the thin-walled condition. Hence in such cases certainly the possible factor of the interference of the cast with cell-division and so with the final result is eliminated.

In the second or third epicotyledonary internode of Vicia faba the hard bast is formed when the whole plant has produced five or six internodes. If however the internode in question is put into a cast before secondary growth begins, no hard bast is formed there till the plant has reached twice the development, that is, till about the time it blossoms. Before this time the xylem within the cast will have thickened several or many walls and outside the cast mechanical xylem and phloem will have been present four or five weeks. Two plants of Althæa tauriensis, which had grown well for eighteen days after a lower internode in each had been encased in gypsum, showed within the confined internodes only thin-walled cells, while above and below the casts hard bast was present as well as thick-walled xylem. Other individuals of the same species, which after similar treatment grew for fifty days, had begun within the casts to thicken the walls of the bast cells. Urtica dioica, grown for twenty-three days after application of casts, had within the casts no thick-walled bast, but considerable in the normal adjoining internodes. Other individuals, after growing under the same conditions of treatment as these for fifty days, had developed hard bast of considerable but less than normal thickness. Archangelica sativa, examined after twenty days' growth with a cast around a segment of its stem, had outside the cast strong mechanical bast, inside the cast only thin-walled cells. Dahlia variabilis when grown with a cast around the stem develops hard bast outside the cast several weeks before it appears within; the same is true of Ricinus communis, Forsythia viridissima and Pterocarya fraxinifolia.

In all these plants in which the delay in the formation of thick-walled xylem and phloem has been considered, there has been an actual extension of the period between the origin of the cells and the assumption of their permanent condition. This is proved by the fact that all of the species that have been grown for a very long time surrounded by casts, and these include all those named above except Althæa and Archangelica, have shown the xylem and phloem cells slowly increasing in thickness of wall after the corresponding elements in unconfined parts of the stems had reached, so far as could be determined, their mature condition.

4. *On the time of cork-formation.*—No experiments were made directly on the formation of cork. The results are thus merely incidental and furnish no information except on the time of the beginning of cork-formation, as influenced by the enveloping casts of gypsum. Whether the influence of the casts is due to the pressure which is soon developed by the effort of the confined tissues to expand, to the protective influence of the envelope, or to some other cause is left undetermined. It seems probable, however, as will appear in the general summary at the close of this paper, that it is the pressure exerted which is the influential factor.

In all of the plants that have given results under this heading, cork-formation appears more tardily within the limits of the casts than outside. This has proved true for Forsythia viridissima which forms phellogen from the epidermis; for Phytolacca dioica and Dahlia variabilis which form phellogen from the first hypodermal row of cells; and for Melianthus major in which the phellogen appears in the innermost part of the cortex.

Effect of mechanical resistance on the permanent condition assumed by cells.

It requires no series of experiments to convince one that if a part of an organ in which primary extension is not complete be so encased that it cannot grow farther, the cells must retain a smaller size than normal. The matter cannot, however, be so easily disposed of; the question of the interaction of the tissues, each striving to expand, still remains. We will consider first the effect on the division of cells; second, the manifestation of turgor between tissues; third, the definitive size of cells; and fourth, the thickness of membrane.

The results of my experiments in those cases where the material was suitable to the purpose have coincided with those obtained by Pfeffer[9] in the roots of seedlings in which he found that cells behind the growing point and in the elongating zone divided after the zone was put into a cast. The cells would thus be found shorter (but more numerous) than they were when the cast was applied. Yet this division without expansion does not progress very far, and it is only the cells that are near the stage of division before being put into the cast that divide within the cast. In cross-sections no division subsequent to the application of the cast has been found. It should be stated, however, that my preparations were not made to give, and were not often of a nature to give exact relations in this direction.

The displacement of tissues due to resistance to growth has been recorded in Aristolochia sipho by De Bary.[10] In this plant the pith is compressed by the approach of the fibrovascular bundles toward the center, the impelling cause being thought to lie in the resistance of the leathery cortex. A similar movement of the fibrovascular bundles toward the center has been induced in many of my plants by the resistance of the cast. The conditions for this displacement are that the gypsum must be laid around the stem before the fibrovascular zone has formed a bridge of mechanical tissue, that the pith contains intercellular spaces or has lost the most of its turgor, that the cortex is in an active condition and does not possess large intercellular spaces. Thus the pith has been compressed in Vicia faba, Urtica dioica, Archangelica sativa, Myrrhis odorata, Curcubita pepo, Melianthus major and Ricinus communis. When such a displacement of tissues has taken place, the pith is more or less distorted or crushed; the elements of the bundles are radially elongated and the vessels generally collapsed; the cortical cells are radially elongated and often assume the shape of palisade cells.

[9]Pfeffer: Druck und Arbeitsleistung, 127.
[10]De Bary: Vergleichende Anatomie, 549.

The explanation for these changes is not difficult to find. The pith is the nearest of any tissue to the close of its growth and has the smallest turgor. The cortex is at the stage of its most rapid extension, and every cell dilates in the direction of least resistance. The young bundles grow also, but the amount of their extension is much less at this time than that of the cortex, consequently they do not check the inward pushing of the latter but are carried by it in against the pith whose cells are thus crowded closely together. This movement continues till the intercellular spaces are filled, or till the pre-existing pith-cavity is closed up, when an equilibrium is established and the cortex grows no farther. Displacement does not always end here, however, for the force of growth in the primary or secondary meristem of the vascular ring may prove sufficient to crowd back the cortical cells, often causing them to show wavy walls and in some plants, as Ricinus communis and Eryngium planum, actually crushing them.

The foregoing paragraph furnishes the key to the understanding of the definitive size attained by cells of various tissues when the resistance to growth is made effective before primary extension has ended. Thus although the cells retain longer than in normal growth their capability for extension, they must of necessity reach a time when that capability is lost. With a stem within a cast the pith-cells generally are found to use the least of any tissue the room for extension furnished by the intercellular spaces. The size which they attain relative to their normal size is very nearly the same which they had when the gypsum was laid around the stem. Thus in Archangelica sativa, which had been encased when young, the pith-cells were found to have one-half the diameter of those above and below the cast, though none of these cells had divided meanwhile. A similar result with a varying proportion in the size was obtained in all the plants experimented with, ten species in all.

Precisely similar results were found in the cells of the cortex, except that they nearly always expand more within the cast than do the pith-cells. In the cortex, however, the power of growth is retained both normally and within casts so much longer than in the pith that there were but few of the plants under experiment that showed cortical cells in their definitive condition. It is true, nevertheless, that the definitive size of these cells would be the same as that possessed several weeks after the application of a cast, for in that period the cortex has reached the full extension allowed by the circumstances and any subsequent expansion will be confined to the bundles. In this case, then, we may reckon the size of the cortical cells after the cast has been around the stem for several weeks as the definitive size; whence it follows, that, like the pith, the cortical cells will reach their definitive state with longitudinal and cross-diameter much less than in normal growth.

De Vries and Krabbe in the writings already cited record the fact that the elements of the xylem, when growing under strong external pressure, will not attain their normal size. My experiments have confirmed this result in every plant used. The difference between the size attained and the normal size differs in various species. In Eryngium planum it was found in one plant to be as two to three; in one plant of Pterocarya fraxinifolia as one to two.

Not only the xylem part of the bundle produces elements of smaller size but the phloem also; though a smaller size for the cambium cells could not be demonstrated. These Krabbe found in his experiments to retain their normal size under all pressures; and it will be remembered as already cited in these pages that Pfeffer found the size of the meristematic cells of the growing points of roots and stems to be unchanged when growing in gypsum casts.

Regarding the ultimate thickness of membrane attained by cells growing against pressure, it may be said that the thickness of wall in undifferentiated fundamental tissue does not seem to be decidedly affected. There are many cases known where the cortical cells, for instance, some time after elongation has ended, thicken up their membranes considerably. Such membranes have in my experiments never been found to become thicker within the casts than normal, nor do they seem to remain much thinner. It is to be understood here that in this group of experiments the casts were applied when the stems were very young and while fundamental tissue was in its primary thin-walled condition; the subsequent differentiation into mechanical cells is not referred to, but only the even thickening of the parenchyma as it assumes its definitive condition. This thickening seems to progress within the cast as well as out of it though the cells within may come far short of attaining their normal dimensions. As soon, however, as the development of mechanical cells be considered, we shall find, as will soon be pointed out, a profound effect produced by the cast. It must be indicated in this place that the question that has just been discussed—the influence of pressure on the thickening of the walls of fundamental parenchyma—may not be answered for every plant by my experiments. In all of my plants the normal thickness attained by this tissue is slight and hence a small variation caused by the cast would be difficult to distinguish. It is possible that in plants in which the fundamental parenchyma forms thicker walls than those used in my work, the effect of casts would be apparent in preventing the normal increase in thickness. It is not at all probable, however, that the opposite will be found true, i. e., that cells will form thicker walls than normal when pressure prevents them from attaining their full size. Precisely this assumption was, however, made by Wortmann.[11] He wound the stems of seedlings with twine and found upon examining them after they had been in these bandages for several days, that the cortical cells had thicker walls than normal. This result, it need not be said, seems contradictory to all of mine obtained by the use of casts. It can, however, I believe, be reconciled.

In the first place, it makes a great difference whether the growth be confined by a twine bandage or by a gypsum cast. In the former case the peripheral cells grow out between the strands, producing considerable distortion always accompanied by a good increase in the thickness of neighboring cell-walls. This has been demonstrated by my experiments on Ricinus communis and Phaseolus multiflorus, the latter being one of the plants used by Wortmann. When these plants, however, were encased in gypsum, no such distortion occurred, nor were any cell-walls, as Wortmann found them, greatly thickened, the same result that a dozen other species of plants have given.

In the second place, the first evident effect of confining the extension of young tissue is the closing up of intercellular spaces. The result is a collenchymatous tissue; for at the angles of the cells the two layers of the membrane are appressed and although the thickness has actually nowhere increased, one must look carefully to escape deception.

[11] Wortmann, Beiträge zur Physiologie des Wachsthums. Bot. Zeit. **47**: 286. 1889.

In the third place when tension is induced within tissues a thickening of the cell-membrane follows.[12] This is shown slightly in some plants in which the cortical cells elongate toward the center of the stem after the application of a cast. It is still more apparent when within a cast a few cells of the cortex die and the neighboring cells crowd in to fill the space. It is shown also in all my preparations at the limits of the casts where great tension has arisen between the confined segment of stem and that portion just outside the cast that is striving to expand.[13] All these cases, however, lie outside the question as discussed by Wortmann.

If now we return to the particular case of Phaseolus multiflorus, each of several individuals has shown that the peripheral cell-walls are much thickened where the coils of the twine bandage have caused distortion. In this plant also there are large intercellular spaces in the cortex at a very early age even before the elongation of the hypocotyl is completed. The bandage of twine or gypsum causes these intercellular spaces to be closed within a few days and as a result there is at the angles of the cells a double thickness of wall, merely an *apparent* thickening. There was only one case in which there seemed to be a possibility that the cortical cells had abnormally increased in thickness of membrane within the cast. Here these cells had elongated considerably toward the center of the stem, and if the membranes were slightly stronger the change would probably be accounted for by the tension called forth. But in this plant it is not certain that the membranes had so thickened; since they were no thicker than sometimes found in very young normal individuals. It can at least be said that Phaseolus multiflorus furnishes no illustration of Wortmann's theory that membranes increase in thickness more than normally when their full extension is prevented by mechanical means. All of the plants used in my experiments have contributed to an opposite conclusion. Moreover, Pfeffer, in his experiments with roots and stems of seedlings, noticed no unusual thickening within the segments enclosed in gypsum.

The outer pith-cells in many of the species recorded in this article become normally thick-walled to such an extent that

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[12] Hegler's work as reported by Pfeffer, Berichte d. k. sächs. Gesellschaft der Wissensch., demonstrates the fact that tension increases mechanical tissue.

[13] For details in these experiments see Newcombe: The effect of mechanical resistance on the growth of plant tissues. Leipzig, 1893.

they pass into mechanical tissue. In no plant have these cells shown thicker walls within than without the casts, and where it can be determined that they have reached their definitive condition they are thinner walled within the casts than normally. Vicia faba and Melianthus major have illustrated the truth of the last statement. In these two plants, the stem, after being confined for several weeks within gypsum, was released and grew for weeks afterward. When sections were made the outer pith-cells were found thinner-walled than normal, though they had reached their definite condition. That they had reached their definite condition was determined from the examination of several individuals at different ages, and thus the time when development ceased could be inferred.

That the xylem elements remain definitely thinner-walled when growing under pressure was determined by Krabbe *(l. c.)* for trees. None of my plants have indicated a contrary result and the two species in which it could be certain that the definitive condition had been reached corroborated Krabbe's view. Melianthus major and Vicia faba have each in several instances been released from casts and allowed to grow subsequently. The xylem elements that had been formed while the casts were present could be easily distinguished by their thinner walls from those formed subsequent to the removal of the casts.

(To be concluded.)

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BRIEFER ARTICLES.

Notes from Vermont.—In January last, while looking over some ferns at the Vermont Agricultural College, I noticed some very fine large specimens which did not look like anything I had ever seen before. On closer examination they proved to be *Dryopteris* (Aspidium) *marginale*, but the fronds were tripinnatifid. I sent a specimen to Prof. Underwood and he tells me that he never saw a like development of this species. These specimens were collected by C. E. Stevens, at Colchester pond, near Fort Ethan Allen, which is also the only Vermont station for *Woodwardia Virginica*.

Myriophyllum scabratum grows in abundance in a little pond in Johnson, Vermont. This is 200 miles farther north than before reported.

Mt. Mansfield is well known as a locality for rare mosses but I can find no account of *Tetraplodon mnioides*, as coming from this locality. I collected this in the summer of 1893 on the skeleton of a hedgehog, in the swamp back of the Summit house. *Aster tardiflorus* was collected in Smuggler's Notch, in the summer of 1893, being another rare plant to add to the long list from this locality.—A. J. GROUT, *Johnson, Vermont.*

Other poisonous plants.—The note by Dr. Harshberger in the April GAZETTE leads me to state that at least two other plants, perhaps not recorded as so endowed, produce in some cases an irritation or poisonous effects, namely: the Osage-orange (*Maclura aurantiaca*) and the star-cucumber (*Sicyos angulatus*). A friend of mine informs me that in working in the maclura hedges he has suffered considerably and when the thorns pierce the skin they seem to leave a poison in the wound.

Another friend has been repeatedly poisoned in handling the star-cucumber. To me the plant is unpleasant to the touch, and particularly the burr-like fruit, but it has never left any well-defined inflammation. Ordinary field barley, however, is extremely unpleasant to the writer, and when an awn is drawn across the wrist, for example, it will leave a line of redness for hours.

Some truckers, I have learned, are affected by celery, and after working in it for a few days the hands become quite swollen. The celery belongs to a family of which many members are poisonous.

Some species of greenhouse aloes are also reported as causing inflammation when the juice is applied to the skin.—BYRON D. HALSTED, *Rutger's College, New Brunswick, N. J.*

EDITORIAL.

MANY BOTANISTS in the United States have felt that the time has come when it would be profitable to make a compact and complete presentation of the North American flora, so far as it is known. It is thought that such a work will make information so accessible that study will be stimulated and knowledge developed much more rapidly. Such a work does not represent the end of investigation so much as a foundation for its more vigorous prosecution. It is with this purpose that certain botanists now announce that arrangements have been perfected for the publication of a "Systematic Botany of North America." The work is to be under the editorial control of Messrs. Atkinson, Britton, Coulter, Coville, Greene, Halsted, Hollick and Underwood; and they have already announced the co-operation of at least thirty more of our best known botanists. It is the intention to invite the largest possible co-operation, in order that the work may be so subdivided as to make its completion possible within a reasonable time. The work is to appear in seventeen volumes, with about five parts to each volume and 100 pages to each part. There will be no illustrations, but full references will be made to published figures. Special features will be the examination of type specimens, the citation of type localities, geographical distribution, and a discussion of the economic, palæontologic and horticultural features of each order. The general sequence of orders adopted is that of Engler and Prantl in "Die natürlichen Pflanzenfamilien," and just as in that work, parts of all volumes may be printed simultaneously. A uniform style of presentation and a consistent nomenclature will be adopted, but each monographer will be responsible for his own matter. It is hoped that five or six parts will appear annually, beginning with 1895.

We cannot but feel that this large undertaking marks an epoch in the history of systematic botany in North America. To attempt to present the complete flora of a great continent in so short a time means great activity and extensive organization, and the large response already obtained testifies to a fine fraternal feeling among American botanists. In the very nature of things such a work will be uneven, but the unevenness will be no more noticeable than that of our great cyclopædias. There can be no doubt that in the course of preparation it will also develop many new investigators of our varied flora. We bespeak for the work the widest co-operation, that it may be made a fit monument to the zeal and industry of American botany and a notable datum-line from which subsequent advances can be more rapidly made.

CURRENT LITERATURE.

A text-book for advanced students.

It was with pleasure increasing page by page that we read Dr. Vines' latest book[1] which is intended as a general survey of the whole field of botany with suitable presentation of its salient features for students. Finding it necessary to revise the English edition of Prantl's *Lehrbuch der Botanik*, Dr. Vines wisely decided that it would be better, while retaining the form of the previous book, to extend it sufficiently to make it suitable for advanced students. This meant complete rewriting. The first half of the book was issued by the publishers in January, in response to numerous requests, and the second half, treating of the classification of seed plants and of physiology, is promised within the year.

The portion before us treats of the morphology, the anatomy and histology, and the classification of plants through the pteridophytes. The first of these topics was the one most in need of thorough and logical treatment, having in mind all members of the plant kingdom, and it is gratifying that it has received just such treatment.

It is really refreshing to have the special morphology of plant members discussed in such a broad and consistent way as Dr. Vines has done. We have long felt that the discussion of these matters in even the best books was obscured by the constant reference of structures to an arbitrary phanerogamic norm. It is beyond doubt that the terminology in common use has been contradictory and confusing to the last degree, largely because we have approached the simpler plants from the direction of the most complex ones. No one book can hope to work a revolution either in ideas or terminology, but this one has wrought out ideas for the most part logically and consistently. In the matter of terminology there has been as little change as possible, we think, consistent with the statement of modern views of homology. Yet to those who are unfamiliar with these homologies and the changed terms already proposed we can well understand how the book would seem almost revolutionary in this respect. Indeed this *has* been made the basis of severe criticism in the *Journal of Botany*.

We observe with gratification that Dr. Vines has abandoned his earlier usage of the words *dorsal* and *ventral* as applied to a leaf, which was the reverse of their ordinary application. This recalls the disap-

[1]VINES, S. H.—A students' text-book of botany (first half). 8vo. pp. x + 430. Figs. 279. London: Swan Sonnenschein & Co. New York: Macmillan & Co. 1894.—7*s*. 6*d*.

proving snort with which Dr. Gray accompanied his pointed comment as he glanced over the preface of Vines' *Physiology* where an explanation of the usage to be followed therein was given: "Humph! if a man wants to call the belly the back and the back the belly I suppose there is no way to prevent it!"

In the discussion of anatomy and histology the author has followed the older lines more closely, too closely, perhaps. In the classification of the tissues, we had a right to expect the abandonment or subordination of the three tissue systems of Sachs and De Bary, which rest mainly on the course of early development and obvious but superficial anatomical relations. This is the more striking since the retention of these tissue systems is scarcely consonant with the adoption of the *stele* as a morphological unit, a step which we think eminently good. Neither is the treatment of the sclerenchyma and sclerotic parenchyma as modern as it might be to its betterment.

Without going into details regarding the third part, the classification of plants, we may say that while we do not think well of Dr. Vines' great divisions (e. g., we cannot agree that Thallophyta constitute a group in anything like the sense in which the Bryophyta and the others do), we especially like the mode of treatment he has adopted, wherein he seems to have chosen the golden mean between overmuch detail and unintelligible generalities.

As a final word we commend the book most heartily to American teachers for the use of advanced students, for whom Goebel's *Outlines* and De Bary's *Comparative Anatomy* were too detailed, too special, and too costly. Here is a work which will serve as the text-book accompanying laboratory courses in general morphology, in histology and in physiology (when the second half appears).

We wish that the publishers would issue the work not only in a single volume, but also publish parts I and II, part III, and part IV (when ready) independently, forming thus three small volumes which might be purchased separately. This would, we are sure, vastly stimulate the sale on this side of the water and be of decided convenience to students. For the manufacture of the book we have only praise. Paper, press-work and binding are all good, and the price (of this half) is low.

Two laboratory manuals.

Teachers and students can hardly claim that there is no choice of laboratory manuals, as the number of these helps is rapidly increasing. Every teacher of botany, however, has his own notions, and the probabilities are that such books will continue to be written till they are as numerous as the teachers. A late publication of this kind is that of Mr. E. R. Boyer,[1] instructor in biology in the Chicago schools, and his book is intended to stand for the work in biology in these very important secondary schools. The book is primarily intended for those schools that wish to offer a year of continuous work in a biological combination of zoology and botany, a thing which we do not believe in, but which is common enough. The greatest step is taken when secondary schools depart from text-book and "analysis" and seriously engage in laboratory work; and the next step in advance is taken when the plant kingdom is presented as a whole. Both these steps are taken in the book before us, which cannot, therefore, be other than helpful. Its further usefulness will depend upon the training of the teacher and the selection of proper illustrative material. That "the inductive method" demands better trained teachers than secondary schools ordinarily possess is unquestionable, but this is no fault of the method. As to the selection of material in the present book, the series of animal types is placed first and not intercalated with plant types, a thing to be commended, although we question the practicability of making the very first exercise a study of Amœba, a thing that no instructor can have time to find for a large class and no beginner can find for himself. The botanical series is much shorter, as it always is in these combination guides, and is made up of Protococcus, Saccharomyces, Spirogyra, Vaucheria, Chara, Marchantia, Pteris, Pinus sylvestris, Trillium recurvatum, and seed studies of bean, corn and pine. We certainly question the omission of all fungi and mosses, especially when the list includes Chara and Marchantia, which are hardly typical of anything excepting themselves. With properly trained teachers, however, the book can hardly help working a revolution in the Chicago schools.

An "Elementary Practical Biology" is the title of an introduction to zoology and botany by Prof. Chas. W. Dodge of the University of Rochester.[2] In plan the author combines to some extent the scheme of Sedgwick and Wilson with that of Huxley and Martin. The work begins with the examination of a drop of stagnant water. He then takes up the study of the cell as seen in one-celled animals and in the tissues of higher animals. A similar study is made of vegetable cells, and this is followed by the study of a series of animals beginning with

[1] BOYER, EMANUEL R.—A laboratory manual in elementary biology, an inductive study in animal and plant morphology. Designed for preparatory and high schools. Small 8vo. pp. xiii + 215. D. C. Heath & Co., Boston. 1894.

[2] DODGE, CHAS. W.—Introduction to elementary practical biology, a laboratory guide for high schools and colleges. 8vo. pp. xxiii + 422. New York: Harper & Bros. 1894.

the sponge and ending with the frog. A similar series of plants is studied from vaucheria to the flowering plant. In the list of plant types it is difficult to discover the principle of selection. Why the blue-green algæ, the red algæ and the mosses should be omitted when Chara and Protococcus are given a place is not apparent. Yeast, penicillium and the mushroom can hardly be said to represent the fungi, nor do their life histories compare in biological interest with those of the rusts, peronosporas and lichens. The types chosen are all familiar figures in the positions they occupy but the list can hardly be said to be up to date from the standpoint of the botanist. The book contains an abundance of material to meet the wants of any school. The directions for dissection are given in the form of questions which are suggestive and stimulating and lead to the latest and best methods of making and exhibiting the more difficult anatomical preparations.

As a manual of dissection the book is a success, but as an introduction to biology it is certainly open to criticism. A number of physiological questions and experiments are introduced after the dissection of each type but the organism is always approached and chiefly studied from the standpoint of the anatomist. For the beginner certainly the working out of anatomical details is chiefly of interest and importance as it bears on the solution of problems of function. A dissection should be so planned as to lead the student to group the facts discovered as bearing on this or that problem in physiology. Details of structure which can not be readily so grouped are of secondary importance in the first year's work in biology.

The chapter devoted to the flowering plants departs from the plan of the book without being an improvement. It is a composite of studies in seeds, stems, buds and flowers of all sorts, with experiments in germination, transpiration, etc. Such studies are of course very useful and interesting but they should certainly be preceded by a study of the life history of some one flowering plant. It is as if the author had substituted for his very comprehensive and thorough dissection of the frog studies on the heads, legs, muscles, etc., of a dozen vertebrates taken more or less at random.

An appendix contains a well selected list of reference books arranged according to the list of organisms studied and descriptions of the more common reagents and their uses.

The typography and general make up of the book are excellent.

Agricultural Botany.

The subject of agricultural botany is a difficult one to treat. There is no well defined range to it. Usually it is made to include the elementary part of all departments of botany, with portions here and there expanded and illustrated to meet the special problems in agriculture. Occasionally a work is made to cover only those features of the science which specially affect agricultural practice. Really good examples of the latter form have not yet appeared in English, although a demand may be expected to arise eventually from our numerous agricultural colleges, if not to some degree already existent.

We believe that the subject matter of a work, which can justly bear the title of "agricultural botany," should be almost entirely, or even wholly, devoted to facts and problems of special interest to the agriculturist. Yet we are aware that many schools, even some agricultural colleges of high rank, do not provide a course in botany sufficiently full for the student to obtain, as he should do, a good foundation in the morphology, anatomy, classification and physiology of plants before entering upon the more special and more detailed study of the plant life as exhibited under the hands of the cultivator. There is a demand for a work of moderate compass at once elementary and expanded upon topics having a practical trend, that is, for a book both general and special, a vade mecum, a short cut to specialization.

The recently issued volume by Mr. M. C. Potter[1] covers this requirement most admirably, since it is well printed, well bound, abundantly illustrated, of handy size, covers a wide range of information, is carefully written, and contains useful matter. The thirteen chapters deal respectively with the introduction, cell, root, leaf, stem, flower, fruit and seed, food, reproduction, diseases, grasses, Leguminosæ, and classification.

The attempt to write for the comprehension of the wholly uninformed in botanical matters, while giving the latest results of research and the most recent views upon unsettled problems, often interferes with a smooth and dignified presentation.

There is little in the work that is novel either in subject matter or method of expression; it is not materially better or worse than many other treatises upon the elements of the science, except an advantage from being a recent publication. It gives another text from which to choose, particularly for the use of classes. It is certainly too much to expect that any farmer, unless he be a recent college graduate, can make much use of such a book.

After granting that the author has made a fairly wise selection of matter for his work, there is little to criticise. The use of the singular form of the word stoma in place of the plural on pages 45–52 may be

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[1] POTTER, M. C.—An elementary text-book of agricultural botany. 12 mo. pp. 250. figs. 99. London: Methuen & Co., 1893.——3*s.* 6*d.*

assumed to be an oversight. The chapter on diseases is very inadequate, and betrays a lack of knowledge of the great advances recently made in this line of study, especially in America. And one is justly suspicious of superficiality in a writer who uses the misnomer "fungoid." The first chapter contains the common attempt to show antithesis between animals and plants. The author in saying that "the plant, if supplied with the various elements required for its structure in the form of mineral matter, can perform all its various functions," etc., while "the animal, on the other hand, requires that all its food should be presented to it in the organic form," forgets or ignores for the time being that more than one fourth of all known species of plants (fungi) are as dependent upon organic food as are animals. Indeed, the fact is recognized a few pages further on, where the author says in another connection that "the fungus, in the manner of obtaining its food, resembles an animal in so far as it can only live on organic matter." How long must it be before writers will be able to forget the old fallacy of opposite characteristics in animals and plants, and come to recognize the unity of the organic world, and emphasize the correspondences rather than the antagonisms?

Botanical Classics.

Wilhelm Engelmann of Leipzig, to whom the botanical world is already greatly indebted for bringing out numerous standard treatises, has undertaken the publication of a uniform series of the most important of the older standard works of science under the general title of *Ostwald's Klassiker der exakten Wissenschaften*, to include works upon mathematics, astronomy, physics, chemistry and biology.

The last issue of the series is Sprengel's "Mystery of nature disclosed in the structure and in the fructification of flowers."[1] It is issued in four small handy volumes, well printed, bound in leatherette, and admirably adapted for perusal or ready reference.

The fourth volume is given up to the plates, which are remarkably well reproduced, although somewhat smaller than the originals. The works are issued at such a low price, and in such an attractive form, that they should greatly stimulate acquaintance of the present generation with the early masters of the science.

The recent centennial anniversary of Sprengel's discoveries makes the general value of his writings well known to all; and this publication gives an opportunity to become familiar with his own words.

[1] SPRENGEL, CHRISTIAN KONRAD.—Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen (1793). 4 vols. 12 mo. pp. 184+172+180+7. 25 pl. (Ostwald's Klass. d. ex. Wiss., Nos. 48, 49, 50, 51.) Wilhelm Engelmann, Leipzig, 1894. M. 2 per volume.

OPEN LETTERS.

A criticism of the "Synonymy of Juncodes."

Having been especially interested for the past few years in a critical examination of the order Juncaceæ, and my attention having been drawn to a recent article by Mr. E. P. Sheldon, entitled, "Synonymy of the North American species of Juncodes,"[1] I desire to criticize this paper because it seems a fair sample of a current class of manuscripts which should *not* be published. Its author having in view a revision of the genus Luzula, or Juncoides, and finding the current nomenclature in an unsatisfactory condition, has proceeded, properly, to make a list of the species, preliminary to his future study of the group. But going further he has published the list in this early stage of its development, before it has been tested by a close examination of either literature or specimens.

The name of the genus was first printed *Juncoides*, not *Juncodes* as quoted by Mr. Sheldon, and was used first by Dillenius in 1719, not by Mœhring in 1736. After the date 1753, adopted by the Genoa Congress as the starting point for our nomenclature, the genus was first characterized by Adanson, who spelled the name *Juncoides*. At least two of the binomials inserted here as new have already been published, and some of the other names can not properly be maintained. The synonymy cited is the same as that given in the last monograph of the Juncaceæ, published in 1890, by Buchenau, he however retaining the Decandollean name Luzula. Since, therefore, the generic name is wrong, since some of the names proposed as new have already been published and others can not be maintained, and since the synonymy may be consulted in an excellent monograph only four years old, the list can not add to our present knowledge of the group any information of material value, and it is only to be regretted that its author did not confine it to its legitimate use, that of a manuscript aid to critical study.

At this time, in the absence of any standard book or check-list of American plants in accord with our system of nomenclature, there is a tendency among active botanists for each to prepare lists of his own, and I have called attention to the present paper only because it is a fair illustration of the undesirable result of publishing such lists when the results are not verified by critical study.—FREDERICK V. COVILLE, *Washington, D. C.*

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[1] Geological and Natural History Survey of Minnesota. Bulletin no. 9. 62–65. 1894.

NOTES AND NEWS.

MR. AND MRS. T. S. Brandegee have removed to San Diego, taking with them their botanical library and herbarium.

WITH THE CURRENT number (March) of *Zoe*, completing the fourth volume, it is announced that its publication will cease for the present.

IN THE Bulletin of the Iowa State Board of Health, 7: *9*, J. Christian Bay gives a brief account of bacteriological work in medical science.

PARASITISM OF Nostoc and Chlorococcum upon Gunnera is treated by B. Jönsson in an illustrated article in the *Botaniska Notiser* for 1894, pp. 1–20.

THE MORE extensive use of pith in hand and microtome sectioning is pleaded for by Dr. Alfred C. Stokes in the February number of Queen's *Microscopical Bulletin*.

DR. THOMAS MORONG, curator of Columbia College, died on Thursday, April 26th. A sketch of his life and botanical work will appear in the next number of the GAZETTE.

DR. DOUGLAS H. CAMPBELL, of Stanford University, expects to sail for Europe early in June to be absent six months. He has in preparation a general work on the archegoniates.

MR. F. H. KNOWLTON has published in Bull. 105, U. S. Geol. Surv., an annotated list of the fossil plants of the Bozeman (Montana) coal field, with a table of distribution, and descriptions of new species.

MR. ERWIN F. SMITH is editing a very interesting department of *Science* under the title "Memorabilia Botanica," in which matters of current interest and publication are presented in a full and attractive way.

THE SPECIES of Isoetes of central France are characterized by M. l'Abbé F. Hy in *Journal de Botanique* (March 1). The three sections are represented as follows: Aquaticæ, three species; Amphibiæ, seven species; Terrestres, two species.

MR. HERBERT L. JONES will have charge of the summer course in botany at Harvard next summer. The only course offered is one in "phanerogamic botany," which means the general morphology and classification of flowering plants and ferns.

AN ENUMERATION of the fungous flora of Portugal by P. A. Saccardo (Boletin da Sociedade Broteriana, 11: 9–70. 1893) gives a total of 1,178 species, of which the four groups of Agaricineæ, Sphaeriaceæ, Sphaeropsideæ and Hyphomyceteæ embrace nearly two-thirds.

A NEW DIVISION, the Division of Agricultural Soils, has just been created in the U.S. Department of Agriculture, as a part of the Weather Bureau, with Prof. Milton Whitney in charge. It is proposed to make a study of the relation of soil to crops and of soil physics.

Bourquelot has found[1] that *Aspergillus niger*, when cultivated in a fluid medium to maturity, excreted a considerable number and variety of enzymes. Invertase, maltase, trehalase and inulase act on sugars; diastase on starch; emulsin on glucosides; and trypsin and pepsin on proteids.

Professor L. H. Pammel, of Ames, Iowa, has published some "Notes on the flora of Texas," being an account of the flowering plants noted in central Texas during a visit in the summer of 1888 and 1889 while engaged in studying the "root-rot" of cotton. The list contains 291 numbers.

The experiment stations of Europe are being described in a series of illustrated articles in the *Experiment Station Record.* The station at Bernberg, famous for the work of Dr. Hellriegel upon the assimilation of free nitrogen by the Leguminosæ, and kindred subjects, is the last one treated.

We are informed by Dr. W. Thornton Parker, in *Science* (Feb. 23), that "the loco-plant is regarded by Professor Gray. of Harvard University, as the *Astragalus legum*, a peculiar species of the Vetch tribe, abundant in the region of the 'Texan Panhandle.'" We wonder where Dr. Gray made such a statement!

Among Messrs. Swan Sonnenschein & Co.'s announcements for the spring of 1894, we note the Handbook of Systematic Botany, by Dr. E. Warming, Professor of Botany in the University of Stockholm, to be translated and edited by M. C. Potter; Flowering Plants, by James Britten; and Grasses, by W. Hutchinson, the two latter in the Young Collector Series.

The Quarterly Bulletin of the University of Minnesota has reached the first number of its second volume. The last issue contains a half dozen botanical papers. All but one, a preliminary note by Prof. Conway MacMillan on the casting off of parts of the aquatic hairs of Azolla, are résumés of articles published in different serials and already noticed in these pages.

A new "sand plum" from Kansas is described and figured by Professor Sargent in *Garden and Forest* (April 4). It is named *P. Watsoni*, from Dr. Louis Watson, of Ellis, Kansas, brother of the late Dr. Sereno Watson, by whom the seed was sent. The plant has been growing in the Arnold Arboretum since 1880, and has been mistaken by travellers in the west for P. angustifolia. It is abundant on the banks of the Saline River.

In the *Am. Micr. Jour.* J. Christian Bay is publishing a series of papers on the study of yeasts. The February number has descriptions and figures of the Hansen culture box and of a new infection needle. A description of the latter also appears in *Ber. d. deutsch. Bot. Gesells.* 12: 1. 1894. The same number of the *Journal* also contains a paper on the aeration of tissues and organs in Mikania and other phanerogams, by W. W. Rowlee.

For making microscopical preparations of algæ which preserve

[1] Bull. Soc. bot. de France **40:** 230. 1893. Cf. Bot. Cent. **57:** 200. 1894.

their structural characters unchanged, Lemaire proposes[1] the following method: Fix in a saturated watery solution of uranic acetate, with 0.3 per cent. chrome alum for 6–12^h; wash thoroughly; transfer to slide into two or three drops of 10 per cent. glycerin (in water); concentrate by evaporation of water under bell jar with $CaCl_2$; mount in Kaiser's glycerin jelly or Behrens' ichthyolglycerin.

Miss Anna Murray Vail has published in *Bull. Torr. Bot. Club* (March 24) the result of a study of *Psoralea* in America. Twenty-one species of palmate-leaved forms are defined, and 14 species of pinnate-leaved forms. Fewer changes in nomenclature were found to be necessary than usual in such a revision, and but one or two new species are proposed. Dr. Otto Kuntze is not followed in transferring all the species to *Lotodes* Siegesbeck.

Forschungs-Berichte über Lebensmittel und ihre Beziehungen zur Hygiene, über forense Chemie und Pharmakognosie is the title of a new journal edited by R. Emmerich, K. Goebel, A. Hilger, L. Pfeiffer, and R. Sendtner, all of Munich. Dr. E. Wolff's new scientific publishing house in Munich will publish the journal. No. 1 contains the beginning of a paper on the anatomy of the Cinnamomum bark, by R. Pfister (pp. 6–13). The list of contributors includes many distinguished names.—Bay.

The membership of the German Botanical Society, corrected to February, 1894, as given in the pages of the last annual volume of the *Berichte*, shows a total of 451, of which 27 are corresponding members and eight honorary members. The list includes five Americans: Dr. W. G. Farlow of Harvard University, Mr. J. Christian Bay of the Iowa Board of Health, Dr. Douglas H. Campbell of Leland Stanford University, Dr. Geo. L. Goodale of Harvard University, and Dr. Albert Schneider of Illinois Experiment Station.

Professor E. L. Greene is discussing and shifting generic lines in the Compositæ. In *Erythea* (April) the "Astereæ" are considered. The merging of Aster and Solidago, as has been done by Dr. Kuntze, is not accepted, it being claimed that there is such a thing as a genus Solidago distinct from Aster if it is stripped of its disguising appendages. He would, therefore, raise Euthamia to generic rank, and also exclude Nuttall's Chrysoma. Several species, also, that have been referred to Aplopappus are brought together under Sir William Hooker's genus Pyrrocoma.

Two vigorous articles in disapproving criticism of the present methods of teaching botany in the secondary schools have lately appeared in *Science*. One is by Miss K. E. Golden, of Purdue University; the other by Geo. H. Hudson, vice-principal of the State Normal and Training School at Plattsburgh, N. Y. Mr. Hudson wields a trenchant pen and his characterization of botanical instruction in high schools, though severe, is sadly too true. We hope he will reprint that article where as many teachers as possible will see it. We are entering upon the period of the *renaissance* for elementary as well as advanced instruction in botany.

[1] Jour. de Bot. 7: 434. 1893.

A NEW Ostrya, from Arizona (Yavapai county), within the Grand Cañon of the Colorado, is described and figured by Mr. F. V. Coville in *Garden and Forest* (March 21). Our only other species (O. Virginiana) extends westward to the meridian of E. Nebraska and E. Texas, and to discover a second species nearly a thousand miles west of this is a matter of considerable interest. The species was originally collected by Mr. Knowlton in 1889, without fruit, but the description was wisely withheld until fruiting specimens were obtained by Mr. Toumey in 1892. It bears the name of its original discoverer, being called O. Knowltoni.

THE NEW HAMPSHIRE COLLEGE of Agriculture and the Mechanic Arts, coöperating with Superintendent Gowing of the State Department of Public Instruction, will institute next July a Summer School of Biology, especially adapted to the needs of teachers in the secondary schools. The instruction in botany will be given by Principal Charles H. Clark, A. M., of Sanborn Seminary, Kingston, N. H. The school will open Thursday, July 5th, and continue until Saturday, August 4th. The course of study will cover the line of work in botany and zoölogy recommended in the recent report of the Committee on Secondary School Studies.

ANOTHER number of *Minnesota Botanical Studies* has appeared, bearing date of March 21st. Its six papers are: Nitrogen assimilation by Isopyrum biternatum, by D. T. MacDougal, in which the tentative conclusion is reached that the tubers are not primarily storage organs, but are probably concerned in the assimilation of free nitrogen; Morphology of hepatic elaters, by Josephine E. Tilden, in which the conditions of branching in the elaters of Conocephalus conicus are especially considered; Revised descriptions of Minnesota Astragali, Synonymy of the North American species of Juncodes (Luzula), and Further extensions of plant ranges, by E. P. Sheldon; Determinations of some Minnesota lichens, by W. D. Frost.

IN *Zoe* for March Mr. T. S. Brandegee continues his valuable studies of the flora of Lower California, a flora which he has done so much to elucidate. Over 70 plants new to the "Cape Region" are noted, several of them being new species, and one a new genus of Compositæ, dedicated to the distinguished botanical artist, Mr. C. E. Faxon. Mr. Brandegee also describes another new genus of Compositæ from the Coast range and dedicates it to Miss Alice Eastwood, the Curator of the herbarium of the California Academy of Science. *Faxonia* and *Eastwoodia* are each illustrated by a plate. The grasses of Mr. Brandegee's Lower California collection of 1893 are presented by Professor F. Lamson-Scribner.

IN THE *American Naturalist* (April) Professor L. H. Bailey asks the question, "Whence came the cultivated strawberry?" and answers that it is a direct modification of the Chili strawberry, Fragaria Chiloensis. He shows that this satisfies "the demand of history, philosophy and botanical evidence," and that we will have to give up "the pleasant and patriotic hypothesis" that it is the offspring of our native berry. "The strawberry is an instance of the evolution of a type of plant in less than fifty years, which is so distinct from all others that three species have been erected upon it, which has been uniformly kept distinct from other species by the botanists who had occasion to know it best, and which appears to have been rarely specifically associated with the species from which it sprung."

IN THE *Annals of Botany* (Dec. '93) Professor J. M. Macfarlane continues his observations on "pitchered insectivorous plants," illustrated by three plates. Darlingtonia, Sarracenia, Heliamphora and Nepenthes are chiefly considered histologically and morphologically and their adaptations for insect-catching discussed. A large amount of patient observation is recorded, and the whole contribution is a valuable addition to our knowledge of this peculiar group of plants. The probable genetic relationships of these four genera are presented in a graphic way, in which it appears that from the "common type" two main branches diverged, one giving rise to Heliamphora, Sarracenia and Darlingtonia, the last being an offshoot of the second, and the other giving rise to the great display of Nepenthes, in which the specific relations are traced out in a similar way.

THE STATION BULLETINS recently issued include leaf blight of the pear, by L. F. Kinney (R. I., no. 27); spraying potatoes, by L. R. Jones (Vt., no. 40), an admirable bulletin; spraying apples and pears against fungi, by H. H. Lamson; potato diseases, by S. B. Green (Minn., no. 32); rational selection of wheat for seed, and typhoid fever, by H. L. Bolley (N. D., no. 15), the latter topic including a description of the germ, and its separation from natural waters, which causes a particular kind of fever; and a provisional bibliography of the more important works pub'ished by the U. S. Department of Agriculture and the agricultural experiment stations of the United States from 1886 to 1893 inclusive, on fungous and bacterial diseases of economic plants, by W. C. Sturgis (Conn., no. 118), a very valuable and apparently complete bibliography, which will prove of much service to investigators and writers.

THE THIRD SESSION of the Hopkins Seaside Laboratory of Leland Stanford Junior University will begin Tuesday, June 12, 1894. The regular course of instruction will continue six weeks, closing July 21st, though investigators and students working without instruction may continue their work through the summer. The laboratory provides for three classes of students: investigators; students in the university, who wish to supplement their work; and students and teachers not members of the university who desire to pursue biological studies and to become acquainted with the practical methods of laboratory work. For this last group of workers regular courses are conducted in zoology and botany, accompanied by lectures and by individual instruction at the work table. Mr. Walter R. Shaw, instructor in botany, in the university, gives a course in the comparative morphology of algæ. Advanced courses may also be arranged for.

The January number of the *Berichte der deutschen botanischen Gesellschaft* contains a paper by Kamienski on new and undescribed Utriculariæ. Frank and Krüger have a paper on the effect of treatment with copper on Solanum tuberosum. A. Schneider presents the results of his Rhizobia-studies, and Julius Klein describes the *Bau der Cruci-*

ferenblüthe auf anatomischer Grundlage. J. Christian Bay describes and figures his new infection-needle. In the February number, De Vries' paper, *Eine Methode Zwangsdrehungen aufzusuchen* forms a fine supplement to his monograph on the same subject. W. Tonkoff has a very interesting communication on swellings of the petiole in *Atragene alpina* L., a climbing plant. H. Zukal makes a communication concerning the much debated cell-contents of *Cyanophyceæ*, and A. Wagner gives the results of his investigations of the anatomy and biology of *Strelitzia reginæ*.—BAY.

PROFESSOR F. LAMSON-SCRIBNER has been appointed agrostologist of the Department of Agriculture, in the Division of Botany. This newly created position has thus been filled by our most critical student of grasses, and it will at once attract to itself the confidence and cooperation of botanists. The duties are as follows: "the identification of grasses and the investigation of forage plants in the Department; to prepare monographs on grasses; to care for the grasses of the herbarium; to identify such as may be sent for that purpose; to conduct correspondence on this subject, and to have charge of any special investigation of grasses and forage plants which may be undertaken by the Department." Professor Scribner needs no introduction to the readers of the GAZETTE, and the Department of Agriculture is to be congratulated upon this further evidence of its desire for competent scientific service.

WITH THE HELP of ten plates Mr. Hermann Schrenk discusses the parasitism of Epiphegus Virginiana, in a paper presented before the American Microscopical Society and now published in its Proceedings, 15: 91–128. A painstaking study of material and literature has evidently been made, though no very definite conclusions are reached concerning questions that were in doubt. There is much presented in work of this kind that may as well be omitted as not pertinent. If the study of each such parasite is to be preceded by an historical résumé of our knowledge of parasitism and a full account of the systematic relations of both host and parasite the resulting papers will be somewhat heavy and monotonous. It is necessary for the student to look up all this extraneous material but not to publish it. It seems to be a crying need just now, when such a multitude of contributions must be considered, for one to say what he has to say in the briefest possible way, and not to lead us gently to it by various circuitous approaches.

OLIVE on PONTEDERIACEÆ.

SETCHELL on USTILAGINEÆ.

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THE

BOTANICAL GAZETTE

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In the July number will appear:

Undescribed plants from Guatemala. XIII, by JOHN DONNELL SMITH, *Baltimore, Md.*

A preliminary synopsis of the North American species of Amaranthus, by EDWARD B. ULINE and WM. L. BRAY, *Lake Forest, Ill.*

Notes on our Hepaticæ, II.—The genus Riccia, by DR. L. M. UNDERWOOD, *Greencastle, Ind.*

Pleodorina, a new genus of Volvocineæ, by WALTER R. SHAW, *Stanford University, Cal.*

Noteworthy anatomical and physiological researches: The fixation of free nitrogen, by DR. H. L. RUSSELL, *Madison, Wis.*

BOTANICAL GAZETTE

JUNE, 1894.

Leaf movement in Cercis Canadensis.

S. G. WRIGHT.

WITH PLATES XIX AND XX.

Among the numerous observations which have been made concerning leaf movement the bulk of attention has probably been given to the investigation of the especially interesting phenomena connected with Mimosa pudica. The histological structure and development of the unusually sensitive pulvinus of this plant has been quite fully described. Numerous other members of the Leguminosæ have well marked pulvini and offer admirable opportunities for physiological and histological study. *Cercis Canadensis* L., while presenting less noticeable leaf movement than the sensitive plant, proves on closer examination to be a very interesting subject for investigation.

In external appearance the pulvini on a mature leaf of Cercis Canadensis consist of prominent enlargements at both the upper and lower end of the petiole. The enlargement at the junction of the petiole and leaf lamina is the principal one in producing the leaf movement, while the enlargement at the basal end of the petiole so far as movement is concerned seems to be almost functionless. In a series of observations made on a number of leaves (given in tabulated form later) no movement of any importance could be detected in the basal pulvinus. The upper or true pulvinus of one of the largest leaves found on a thriftily growing tree gave the following measurements.

Length on upper surface	5. mm
Length on lower surface	7.5 mm
Horizontal diameter, lower end	3. mm
Horizontal diameter, upper end	2.5 mm
Average horizontal diameter of petiole	2. mm
Average vertical diameter of petiole	1.8 mm

In the true or upper pulvinus, which shall receive the bulk of attention in this paper, the upper end may be said to form a portion of the upper surface of the lamina of the leaf, while the leaf veins, seven in number, of which the central one is probably twice the size of either of the others, are given off from its margin. An upper view of the mature pulvinus is given in plate XX, fig. 3. When a mature pulvinus presents a series of transverse markings or wrinkles it may be taken as an indication that the leaf is capable of very great movement. This is found to be quite true in the case of the plant under study. In a series of observations made on a number of leaves at different times during the day it was found that the angle between the petiole and the lamina varied nearly 100 degrees. With slight modifications due to variations in temperature and light the daily movement of the leaf may be said to be as follows: The rise, beginning approximately at 3 A. M. is continued quite rapidly until 9 A. M. A slight decline then occurs, the lamina again rising to near its forenoon position at about 2 P. M. After this time rapid falling takes place, the full sleep position being reached at about 10 P. M.

1. MOVEMENT OF UPPER PULVINUS. FIRST DAY.

TIME OF DAY.	ANGLE OF LEAF-BLADE WITH PETIOLE IN DEGREES.						TEMPERATURE. °F.	AVERAGE MOVEMENT IN DEGREES.
	LEAF 1.	LEAF 2.	LEAF 3.	LEAF 4.	LEAF 5.	LEAF 6.		
2:30 A.M.	41	41	21	30	32	18	80	52.16
5	93	97	63	90	75	78	82	16.33
6	104	113	78	102	97	100	82	13.33
7	118	127	88	117	111	113	76	– 3.16
8	112	127	82	118	105	111	76	– 8.
9	92	129	78	104	97	107	76	– 3.66
10	91	125	79	90	96	104	85	–12.83
11	85	118	67	75	72	91	87	– 8.83
12 M.	83	112	56	60	67	77	88	1.5
1 P. M.	88	104	60	61	68	83	88	6.66
2	95	111	63	73	71	91	85	9.16
3	105	125	73	81	84	91	80	6.33
4	114	128	80	91	90	94	78	17.83
5	127	144	92	113	116	112	76	– 9.16
6	112	131	95	113	103	95	71	–14.33
7	101	114	85	87	90	86	71	–16.83
8	84	91	74	70	71	72	67	–15.16
9	71	77	58	58	57	50	65	–10.83
10	60	61	43	60	46	36	66	

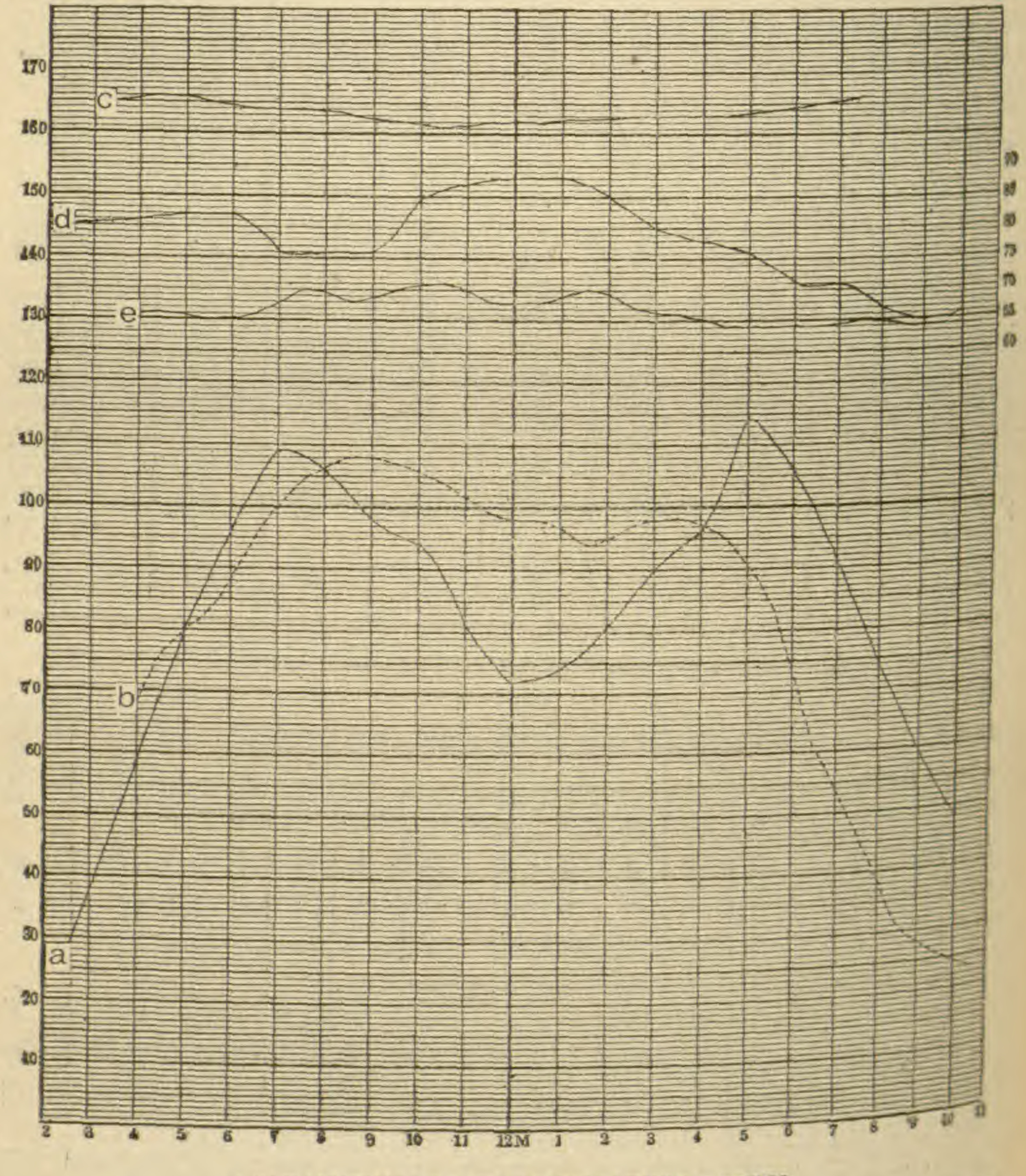
2. MOVEMENT OF UPPER PULVINUS. SECOND DAY.

TIME OF DAY.	ANGLE OF LEAF-BLADE WITH PETIOLE IN DEGREES. LEAF 1.	LEAF 2.	LEAF 3.	LEAF 4.	LEAF 5.	LEAF 6.	TEMPERATURE. °F.	AVERAGE MOVEMENT IN DEGREES.
4 A.M.	85	81	51	76	71	65	66	
4:30	91	91	59	81	81	76	66	8.33
5:30	97	101	68	85	82	89	65	7.16
6:30	105	114	80	100	94	101	66	12.
7:30	119	124	89	106	100	110	70	9.
8:30	121	131	90	115	104	113	68	4.33
9:30	127	131	90	113	101	106	70	– 1.
10:30	123	134	91	96	90	116	71	– 3.
11:30	115	125	90	93	87	111	68	– 4.83
12:30 P.M.	110	122	92	92	88	113	68	– .66
1:30	108	118	85	89	84	109	70	– 4.
2:30	110	123	90	90	84	114	67	3.
3:30	115	120	94	90	83	112	66	.5
4:30	116	120	94	83	75	110	64	– 2.66
5:30	109	109	95	69	59	97	64	–10.
6:30	85	80	71	51	40	65	64	–24.33
7:30	72	68	55	38	24	46	65	–14.83
8:30	56	51	37	24	19	29	64	–14.5
9:30	49	40	29	23	17	30	64	– 4.66
10:30	45	37	21	20	17	30	64	– 3.

3. MOVEMENT OF LOWER PULVINUS.

TIME OF DAY.	ANGLE OF PETIOLE WITH STEM IN DEGREES. LEAF 1.	LEAF 2.	LEAF 3.	LEAF 4.	LEAF 5.	LEAF 6.	LEAF 7.	LEAF 8.	LEAF 9.	LEAF 10.	LEAF 11.	LEAF 12.	TEMPERATURE °F.	AVERAGE MOVEMENT IN DEGREES.
3:30 A.M.	180	146	150	180	172	160	165	150	143			171	65	
4:30	180	148	152	180	174	162			143	171	175	171	66	.8
5:30	178	150	152	180	175	160	169	150	146	165	173	171	65	–.6
6:30	175	146	150	180	172	163	168	151	144	167	172	166	66	–1.25
7:30	177	146	152	177	172	163	171	150	144	163	172	169	70	.16
8:30	171	142	150	176	171	160	163	150	145	167	173	170	63	–1.08
9:30	170	143	151	174	170	160	166	149	143	163	168	170	70	–1.33
10:30	170	143	150	176	169	158	165	148	140	163	166	168	71	–.92
11:30	171	143	151	174	171	158	168	149	144	162	163	170	63	.66
12:30 P.M.	172	142	150	173	169	161	166	149	142	164	164	168	63	–.33
3:30	170	140	152	176	169	164	168	153	142	164	169	170	66	1.41
4:30	172	141	151	173	165	162	166	154	144	167	169	169	64	–.33
5:30	171	143	152	177	166	162	169	159	142	167	168	168	64	.92
6:30	173	145	150	177	170	164	167	155	146	169	169	169	64	.83
7:30	178	147	154	175	171	162	167	153	145	170	170	169	65	.58

Above in tables 1, 2 and 3, are given the various observations as made on a number of leaves. Tables 1 and 2 show the observations made on the upper pulvinus during two consecutive days. Table 3 shows the observations made on the lower pulvinus during a single day. The time of day at which each observation was made is given in the left hand



LEAF MOVEMENT AND TEMPERATURE CURVES.

column. In the central part of the table are given the exact readings in degrees as made on the separate leaves. In the column at the extreme right is given the average movement in degrees for the entire number of leaves observed, during the time between observations. The downward movement in each case is marked with a negative sign. The temperature at the time the observation was made is given in a column near the right.

These observations were made about the first of March on small plants grown in the green house that were brought from the forest in the previous autumn. The average movement given in the last column in each table together with the temperatures are shown above plotted in the form of curves. Curves *a*, *b*, and *c* correspond respectively with tables 1, 2, and 3. Curves *d* and *e* are temperature curves; *d* corresponding with table 1, and *e* with tables 2 and 3 (the observations in tables 2 and 3 being made at the same time). In plotting curves *a*, *b*, and *c* the average position of the leaves at 5 o'clock A. M. is taken as a starting point in each case, thereby admitting of the graphical representation of the actual position of the leaves at any given time as well as of their average movement. The degrees of the angles are represented on the ordinates, and the time in hours on the abscissæ. The noon point is marked 12 M. Fractions of a degree less than five-tenths are not taken into account, but when five-tenths and over they are counted as one. The degrees of temperature for curves *d* and *e* are indicated at the right near the top. In comparing curves *a* and *b* it will be seen that in *b* the forenoon maximum is reached much later, and that the fall of the leaf in the afternoon takes place much earlier than in *a*. This may be attributed to the fact that in *b* the temperature was much lower than in *a* (see temperature curves *e* and *d* respectively), and that the movements represented by curve *b* were on a cloudy as compared with a bright sunny day in the case of *a*. Curve *c* is to represent the results of the observations made on the basal pulvinus, as given in table 3. The curve seems to indicate a slight decline of the petiole during the middle of the day, but on account of the difficulty experienced in reading the leaf angles to fractions of a degree, I do not feel safe in giving this as a final conclusion. Fig. 1 and 2, plate XIX, are from photographs and show respectively the position of the leaves at night (three o'clock A. M.), as compared with their position in the daytime (eight o'clock A. M).

For the histological investigation of this subject a series of twelve collections were made, beginning with the first swelling of the leaf buds in spring and ending with the mature leaf. The time required for the full development of the leaf is one and a half to two months, or from the first of May to the middle or latter part of June. A goodly amount of each collection was dehydrated in Schultze's dehydrating apparatus and then put in absolute alcohol. In connection with the material as above described a large part of each collection intended for coarser work was placed directly in alcohol. In addition to the supply of alcoholic material a number of young thrifty sprouts were taken from the woods in September and placed in pots in the green-house with the hope of at least inducing an early development of leaves for histological and dynamical study. This experiment was quite successful and leaves both on the old branches and on new shoots sent up from the roots afforded ample supply of material throughout the latter part of winter and early spring for all necessary purposes. The young sprouts developed from the roots were the ones on which the observations on leaf movement as above described were made. The observations were not made, however, until after the leaves had attained almost if not entirely their full development. I also undertook to secure growing material from seeds, but on account of defects in the seed obtained the experiment was unsuccessful.

In the imbedding work, the paraffin method as described by Moll[1] of Groningen, Holland, was used. It was, however, found necessary to modify the method in some respects in order to obtain the best results. The most perfect infiltrations were obtained by subjecting the tissues while in pure turpentine to a temperature of from 40–45° C. for several hours. In all cases the fresh material taken from the greenhouse supply and hardened in picric or chromic acid gave the best results. Very little staining was done, but where undertaken haematoxylin was found to be the most satisfactory.

The mature pulvinus is composed of parenchyma, collenchyma, bast and woody tissue. The parenchyma is probably of first importance, since by changes in its turgescence the movements of the leaf are produced. The collenchyma, which in the petiole comprises the layer of cells immediately under the epidermis, is poorly if at all developed in the pul-

[1] The application of the paraffin imbedding method in botany. Botanical Gazette **13:** 5. 1888.

vinus. The bast which occupies the outer portion of the fibrovascular region forms a complete ring of closely set thick walled cells, and together with the woody tissues evidently constitutes the fulcrum or negative element in producing the leaf movement. By the use of the phloroglucin [2] test for lignin it was found that in the petiole the wood-cells, scalariform vessels and bast were highly lignified, while in the pulvinus only the scalariform vessels with some traces in the wood-cells gave the lignin reaction. The bast in the pulvinus was entirely unlignified and seemed to be much more easily macerated by the acid used in the test than in other parts. In the pulvinus the bast is much more closely packed around the woody tissue, the sieve-tubes and phloem parenchyma being less prominent than in the petiole. The position of these various tissues will be seen by an examination of figs. 4–12 inclusive, plate XX, which are intended, however, to show chiefly the changes in position of the fibrovascular bundles as they pass through the pulvinus. Fig. 4 is from a transverse section made at about the middle point of the petiole. The fibrovascular [3] portions occupy a single completed ring surrounding a centrally placed mass of parenchyma. In fig. 5, which is from a transverse section immediately below the upper pulvinus, the fibrovascular part is divided into two complete rings, in the larger of which there is evidence of still farther subdivision. Figs. 6–11 inclusive are from transverse sections through the upper pulvinus about equally distant from each other from the base to the top. In fig. 6, which is from the lowest section in the series, there is still more evidence of subdivision than in fig. 5; the peripheral parenchyma is more prominent, and the bast is seen to be slightly closer to the woody portions. In figs. 7–11 inclusive the peripheral parenchyma is the prominent feature. The greater diameter of the parenchyma cells seems to be at right angles to the longer axis of the petiole. In fig. 7 the fibrovascular portion is indefinitely and irregularly divided, while in figs. 8, 9 and 10 there seems to be a rearrangement of parts culminating in fig. 10 in three distinct bundles arranged as nearly as possible in a single plane, with the bast tissues closely packed around the woody portions. This is evidently the point of greatest flexure in the

[2] Goodale's Physiological Botany, 14.
[3] See explanation of plates, for lettering of drawings.

pulvinus. Fig. 11 shows the divisions of the fibrovascular parts as they enter the lamina of the leaf. At point *v* is shown a portion of a longitudinal section of one of the veins of the lamina. Fig. 12 is from a dorsiventral median longitudinal section of the upper pulvinus, point *x* being the lower and point *y* the upper end. In this section the fibrovascular portions appear only in a single line as they pass through the pulvinus.

From an examination of the nine drawings just explained it is evident that the fibrovascular bundles, which in the petiole are arranged in a single completed ring, are rearranged as they enter the pulvinus in a plane corresponding with that of the lamina of the leaf, thus offering the least resistance to vertical movement.

Francis Darwin[4] describes the first appearance of the pulvinus in the cotyledons of seedlings of Oxalis corniculata as a transverse zone of longitudinally compressed parenchyma cells. This transverse zone of cells he says makes its appearance about the second day of germination. In the plant under study it is possible to demonstrate leaves in the unopened winter buds of much less development than in the case cited by Darwin. By means of serial longitudinal sections of leaf buds passing dorsiventrally through the leaf petioles, leaves were found in which no evident trace of a pulvinus could be made out. This is true, however, only of the most minute traces of leaves; that is, leaves in which no differentiation into lamina and petiole could be made. In these embryonic leaves the first appearance of the pulvinus may be demonstrated. The pulvinus, as I believe, comprises in the broadest sense simply a continuation of the mesophyll tissue of the lamina down the petiole of the leaf. More carefully stated, it is an enlargement of parenchyma tissue at the upper end of the petiole corresponding both in development and structure with the loose parenchyma of the lamina of the leaf. It is a well known fact that all gradations of connection between the stipules[5] and the lamina of the leaf in various plants can be traced. The stipules may be a part of the lamina, or they may be only partially separated from it leaving a winged petiole, or the petiole may be naked as in the case of Cercis Canadensis leaving the

[4]The Power of Movement in Plants 119. 1881.
[5]Gray's Botanical Text Book, sixth edition, 1: 105–107.

stipules entirely distinct. With equal propriety a portion of the leaf lamina may remain in connection with the petiole and by special modification be changed into an organ for the production of motion. By means of dorsiventral longitudinal sections of the smallest leaves in which a distinction of parts could be made, the structure of the leaf, with the exception of a layer of epidermal cells along the dorsal (lower side when the leaf is expanded) surface together with a few parenchyma cells, was found to be uniform throughout. The next stage of development examined showed traces of scalariform vessels with evident parenchyma in both petiole and lamina. In the largest leaf which could be obtained from an unopened leaf-bud the parenchyma and fibrovascular portions of the petiole and lamina were found to be well developed and at a point in the petiole near the base of the lamina were to be seen a number of parenchyma cells showing evident irregular cell division. This irregular cell division I consider as the first appearance of the pulvinus. It corresponds closely with that taking place in the increasing mesophyll tissue of the lamina of the leaf and is in fact connected with it. Examination of more advanced leaves shows only an increase in number of these irregular cells until the mature pulvinus is reached which is composed in the main of loose irregular parenchyma. In contrasting the first appearance of the motile organ in the plant under study with that noted by Darwin in the case of Oxalis corniculata, I should say that while he observes the first appearance of the zone of cells which is to become the pulvinus from the fact of the transverse regularity of the cells, the exact opposite is true in the case of Cercis Canadensis, the first appearance of the pulvinus becoming evident from the fact of the irregularity of the cell division as contrasted with the regular cell division in the remaining portion of the petiole.

In summary it may be said that the pulvinus of Cercis Canadensis consists in the mature form of collenchyma, parenchyma, bast and woody tissue so arranged as to produce with the least expenditure of energy on the part of the plant under the influence of light a daily movement in the leaf lamina of nearly one hundred degrees. This motile organ is to be considered as a development through multiplication by irregular cell division of a portion of the parenchyma tissue at the upper end of the petiole, and moreover the development of these irregular cells is seemingly in nowise essentially different either in time or character from that taking place in the mesophyll tissue of the lamina of the leaf.

Purdue University, Lafayette, Ind.

EXPLANATION OF PLATES XIX AND XX.

Plate XIX.—Cercis Canadensis as affected by light.—Fig. 1. Position of leaves at 3 o'clock A. M.—Fig. 2. Position of leaves at 8 o'clock A. M.

Plate XX.—External and sectional views of petiole and pulvinus of mature leaf.—Fig. 3, × 1⅓; Figs. 4–11, × 30; Fig. 12, × 12. *a*, epidermis; *b*, collenchyma; *c*, peripheral parenchyma; *d*, bast; *e*, sieve tubes and phloem parenchyma; *f*, scalariform vessels and wood cells; *g*, pith parenchyma; *v*, portion of long. section of vein of leaf lamina; *x*, lower end of pulvinus; *y*, upper end of pulvinus. All drawings of sections were made with camera lucida.—Fig. 3. Upper surface of mature pulvinus.—Fig. 4. Trans. section at middle point of petiole.—Fig. 5. Trans. section of petiole immediately below the base of the pulvinus.—Figs. 6–11. Trans. sections approximately 1^{mm} apart, from lower to upper end of upper pulvinus.—Fig. 12. Median dorsiventral long. section of mature upper pulvinus.

Thomas Morong.

WALTER DEANE.

It is with feelings of sadness and regret that we are called upon to record the death of another of the older botanists, who are far too rapidly passing away from us. Dr. Thomas Morong belonged to the old school of systematic botanists, and during his life rendered an important service to science. His botanical career was unique in many ways. Though a clergyman by profession, he always pursued with undying enthusiasm his botanical studies in the face of many difficulties incident to the duties of a country minister, and late in life he abandoned entirely his profession to give himself up without restraint to the study of systematic botany in those branches to which he had always given his especial attention.

Thomas Morong was the son of Thomas Morong of Salem, Mass., and Jane C. Travers of Newmarket, Md. He was the eldest of four boys, and was born in Cahawba, Ala., Apr. 15, 1827, but as his father, who kept a store and owned a plantation, died when young Thomas was fifteen years old, the family moved north and settled in Woburn, Mass. Here he attended Warren Academy, and, part of the time, Hathaway's boarding school in Medford near by. He received a preparatory education at these two schools, and went to Amherst, where he was graduated in 1848, and on Aug. 24th of this year he married Mary L. Bennett, daughter of Rev. Joseph Bennett of Woburn, Mass.

He then entered the Harvard Law School, and for a time was a student in the office of Judge G. W. Warren of Charlestown, but the practice of the law being distasteful to him, he did not complete his studies. He then decided to enter the ministry, and accordingly went to Andover Theological Seminary, completing his course in 1853. He was ordained as a Congregational minister at Pepperell, Mass., Apr. 12, 1854, and from that time till 1888 he had charge of various parishes. In 1876 he went to Ashland, Mass., to supply the pulpit at the Congregational church. He was installed as pastor in 1878, and there he remained among his people, much beloved by them, for ten years.

Dr. Morong early acquired a strong taste for botanical pursuits, and as early as 1861 he built a greenhouse with his own hands and stocked it with plants. For two winters he had a class in botany in Ashland, and he was always ready to take his friends on a tramp, and instruct them in the secrets of the plant world and of nature generally, in a most delightful and unassuming manner, as those who have been with him abundantly testify. Through his own collecting and by purchase he acquired a large herbarium of North American phænogams, which was especially rich in aquatics. He always had a preference for flowering water plants, and in this branch he was an ardent student, besides having a wide knowledge of botany in general. He was preeminently a field-botanist, and it was a familiar sight to see him tramping off to his favorite ponds and streams, armed with his box and dredge. His keen observation, mature judgment, and wide knowledge of his subject combined to produce work of the highest order, and Dr. Morong holds a most honorable position as a systematic botanist.

During the botanical expeditions which he made from time to time he studied the flora of many of the eastern states, and his name is familiar in almost all of our local floras, as well as in our leading botanical papers, which are enriched by his valuable notes especially on the aquatic vegetation. The order to which he gave the most attention was the Naiadaceæ, and his name will always be associated with the genus Potamogeton, one of the most difficult, but to him most fascinating of studies. Not only did he investigate these plants thoroughly in their native haunts in pond, river and stream, but he carried on an extensive correspondence with American and European botanists in regard to them. It is a matter of congratulation that after so many years of honest, conscientious work, he at last published in March, 1893, in the Memoirs of the Torrey Botanical Club, "The Naiadaceæ of North America" with illustrations of every species. This work attracted much attention, and is a fitting monument to the author who died so soon after its publication.

In 1888, Dr. Morong carried out a plan which was to change completely the current of his life. This move of his showed clearly his ruling passion. He often had said to his confidential friends that he must do something for science, and he longed to go to South America and collect plants through the great water-ways that intersect the country in every direction. He resigned his pastoral charge, collected a sum of money through the Torrey Botanical Club of New York, and a few kind friends, and on July 30, 1888, followed by the good wishes of his towns-people who presented him with a purse of money, he embarked on board the sailing vessel, Evie J. Ray, laden with lumber, for Buenos Ayres. He reached his destination in just ten weeks, and after a short stay in Argentina to perfect his plans, he went to Asuncion, Paraguay. Here he collected the rich and varied flora of this region till July, 1890. His enthusiasm was unabated, and though alone and unaided he sent back to the Columbia College Herbarium in New York about 900 species of phaenogamous plants, besides many ferns and mosses.

During his stay in Paraguay he went as naturalist on an exploring expedition up the Pilcomayo river, in the interest of the Paraguay Land Company. This trip of 400 miles into the heart of the Chaco wilderness, on a small flat-bottomed steamer was full of adventures with the wild natives and wilder jaguars, but Dr. Morong returned safely after an absence of six months to Asuncion with a large collection of valuable plants, consisting of about 2,500 specimens, including some 225 species, many of them new to science. As an illustration of the many difficulties to be overcome on the expedition, he writes the following: "We came upon a cataract of which nobody had ever heard, with a fall of five or six feet of water, and steep banks fifteen or twenty feet high each side of it. At first we thought this a 'stumper,' but finally we dug away an ascending plane on one side, and actually pulled the steamer, weighing five or six tons, up the falls by land." In July, 1890, he returned to Buenos Ayres, and after a considerable delay owing to the revolution raging at that time, he sailed around the cape to Valparaiso, Chili, where he met his brother after forty years of separation. From there he went to his brother's home at Caldera, in northern Chili, and for some weeks he revelled in the rich flora of the Atacama desert. He was astonished at the extraordinary sand, plain and hill flora of this remarkable region. "Strange, isn't it, that a desert should yield many flowering plants," he writes. On Oct. 25, 1890, he sailed for home, by way of the isthmus, reaching New York the following month. He had collected during his trip, entirely with his own hands, 20,000 specimens of plants, a collection rendered doubly valuable by his copious field notes.

On his return home, Dr. Morong accepted the position of curator of the herbarium at Columbia College, and there, for three years, among congenial friends and co-workers, he devoted himself heart and soul to his botanical studies. In 1892, in conjunction with Dr. N. L. Britton, he published the results of his work in Paraguay, "An Enumeration of the Plants collected by Dr. Thomas Morong in Paraguay, 1888-1890." This work is a valuable contribution to science, and it is pleasing to see that Dr. Britton has shown his appreciation for Dr. Morong's labors by dedicating many new species to him. His life in New York was a busy one. Besides the duties of his position and the original researches he was always carrying on in the herbarium, he was constantly writing for the various botanical journals. He conducted classes in botany at Barnard College, New York, and delivered lectures at the Biological Laboratory at Cold Spring Harbor, Long Island, at the Brooklyn Institute and elsewhere.

In December, 1893, he went south to shake off a bad cough which he had contracted in New York, but it was of no avail. Reaching Jacksonville, Fla., he was obliged to go to St. Luke's Hospital, and there he stayed till the middle of April, hoping against hope, for consumption had set in. The few lines which he was able to write showed his old enthusiasm, and his determination to recover. He returned north with much difficulty in April and went to his son's house in Boston where he died April 26, 1894, at the age of sixty-seven years. The funeral services were held in Woburn, and he was buried there in the family lot. His death was a peaceful ending to a well-spent life.

Cambridge, Mass.

The influence of mechanical resistance on the development and life-period of cells.

FREDERICK C. NEWCOMBE.

(Concluded from p. 199.)

The effect of external mechanical resistance on the duration of the life-period of cells.

The fact that meristem in growing points, in the cambium and in zones of plants that increase by intercalary growth, may preserve its functional capability for many weeks while the tissue is held in an apparently inactive condition by gypsum casts has already been shown. From what is now to follow it will appear that the life-period of cells may be prolonged if their growth or that of neighboring cells is mechanically restrained.

After young aerial shoots of Juncus effusus had been, without detaching them from the rhizome, kept in gypsum casts for some time, the longest period being eleven weeks, that part of the shoot above the meristem showed a thicker living peripheral zone of tissue than was there present when the shoot was put into gypsum, and thicker than normally occurs at any time in this stem. The greater thickness was not dependent on a radial elongation of cells so much as on an increase by two of the number of circular rows of cells over the number normally found. If growth had not been interfered with, the shoot in elongating and enlarging radially would have increased the size of its dead central mass of stellate cells by first the branching and then the death of these two innermost rows of living cells. As it was, the central cylinder of cells that were dead when the cast was applied had been crushed together by the inward push of the newly formed cells while the latter had lived much beyond their usual life-period.

Two shoots of Equisetum limosum that had grown not more than 3^{cm} or 4^{cm} above the ground and whose internodes had not nearly completed their elongation were so encased in gypsum that the apex of the stem was left free. Thus they grew for three weeks reaching a height averaging over 20^{cm}. The stems increased but slightly in diameter in this time and the internodes within the casts did not elongate. In these internodes the intercarinal canals had not formed in one plant, their place being occupied by living cells, while in the other plant but two or three cells had died in each of those positions. Above and below the limits of the casts the canals were of large size. It need hardly be mentioned that normally these canals arise mostly by the destruction of cells. Similar preparations to the foregoing but in which the stems were left in the gypsum twice as long, had, when examined, canals within as well as without the casts.

A young plant of Zea mais the lower part of whose stem was so encased in gypsum as to prevent elongation of one of its internodes to one-third of what it would have been, had not within the cast thirty-seven days afterwards formed the usual lysigenous canals in the vascular bundles, the thin-walled cells being there undisturbed and living, while in other parts of the stem they were destroyed. Here since there was but slight constriction of stem made by the cast, the prolongation of the life of the cells in question is probably to be referred to the checking of the elongation of the internode.

The growth of the leaves of Allium cepa is not easily confined by a surrounding cast; since, when the tip of the leaf is left free the organ glides through the gypsum because of the very smooth surface of the former. This gliding can be prevented, however, by bending the leaf into a zigzag course and so fixing it before the gypsum is poured on. By pursuing such a method young leaves have been encased and the parts within casts have been kept from becoming inflated while all cells remained alive. In the same leaves, above and below the casts the normal inflation took place two or three days after the casts were applied. The longest period that the central cells of such leaves within casts have been kept alive is fifteen days, or from eleven to twelve days after such cells had died in parts outside the casts.

Sachs[14] has shown that if an onion is germinated in the dark, its leaves will not become hollow. Histologically this means that the normally assimilating cells of the periphery will not be developed in their usual H-palisade form, when light is absent. It is at the time of the rapid extension of the peripheral cells of the young leaf to the dimensions of these assimilating cells that the central hyaline mass of the

[14] Sachs: Ueber den Einfluss des Tageslichtes auf Neubildung und Entfaltung verschiedener Planzenorgane. Botanische Zeitung, Beilage. 1863.

leaf is torn and the leaf changes from the thin, sword-shape to the inflated. The cast effects what darkness effects; in both cases the small peripheral cells remain undeveloped. But casts better than darkness preserve the life of the central, hyaline cells, since the larger etiolated leaves always undergo considerable peripheral extension and always show a narrow cavity lined by fragments of destroyed cells. That this central part of the leaf has not been kept alive longer than about two weeks is accounted for by the fact that at about that time the leaf, which is plano-convex, in its effort to expand folds inward on its flat side, thus crushing the delicate central cells.

The petiole of Ricinus communis when unextended contains no central cavity, but a wide one extended. By applying casts the death of this central mass of tissue has been prevented for about three weeks longer within than outside the casts.

With the rhizome of Triticum repens a similar result was obtained, the internodes being allowed to reach not one-half their normal size, and the cavity appearing above and below the casts before appearing within.

Before elongation was complete, casts were put around the stems of Caltha palustris, Lamium garganicum, Urtica dioica and Vicia faba. All of these plants form central cavities during elongation or at its termination, partly by the schizogenous partly by the lysigenous method. All of them have preserved alive the pith of those parts of the stem within the casts longer than in the parts outside the casts. The period of this preservation was not determined for any species; nor is it a matter probably of much moment since the duration of the period depends largely on the time of application of the cast relative to the development of the part concerned. The younger the organ is when enclosed in gypsum, the longer will its cells remain alive. It should be stated that the longest period of experiment was that in the case of Vicia faba, in which several individuals were found with pith wholly living within the casts 116 days after it would have died normally. In the third internode above the cotyledons, the internode used in these experiments, the cavity normally appears some time before elongation is ended. The plants in which the pith had been preserved for 116 days longer than usual had reached nearly a meter in height and had seed-pods half grown.

Similarly to the cells of the pith, the life-period of the cortical cells has also been prolonged. Lamium garganicum, Urtica dioica and Vicia faba have shown dead cells in the cortex outside the limits of the casts, when within the casts all cells have remained alive.

There have come under my observation two species of plants in which, sometimes but not always, cortical cells are crushed within the casts before any dead ones appear outside the casts. These plants are Ricinus communis and Dahlia variabilis. This result is apparently brought about by the growth of the fibrovascular zone, the turgor there present being sufficient to cause the less resistant cells of the cortex to collapse, whereas similar cells outside the limits of the casts live for some time longer, though the tissue which they form becomes looser and looser by the separation of cells.

In all of the foregoing cases in which the life-period of cells has been more than normally prolonged, the cells were prevented from attaining their full size by confining their growth before they were fully extended. But in certain cases the death of cells may be deferred by checking the growth of surrounding tissue after the cells in question have reached their full extension. In Sambucus nigra and Helianthus tuberosus, for instance, where the pith lives for several weeks after secondary growth has begun, a cast applied after the pith has grown to its definitive size will preserve the pith alive for several weeks after it dies above and below the limits of the cast.

Summary.

I. *Meristematic tissue of growing points, intercalary zones and cambium will preserve for a considerable period its functional capability when growth is prevented by an external mechanical resistance.*

II. *When in such meristematic tissue growth is checked by mechanical resistance, the tissue remains apparently unaltered; the cells do not divide, nor the walls become thicker, nor the composition of the walls undergo change.*

Especial attention may be called to the biological significance of the two facts just stated, and to the resemblance to what takes place when growth ceases because of cold or insufficient moisture. It is manifestly to the interest of the plant-organism not only that the life of meristematic tissue should be retained but that the primary condition of this tissue should be retained, instead of the passing of such tissue over into a permanent state where growth could not be resumed when the obstacle to growth should be removed.

If it should be found—what neither Pfeffer, Krabbe nor I have once observed—that in some plants the cell-walls of the meristem become slightly thicker during the enforced rest of this tissue, as Krüger[15] found thickenings to arise in the radial walls of the cambium of some plants during the winter rest, the importance of the biological truth would not be altered, that the meristem retains its functional capability.

That the cell-contents may change during mechanical resistance was shown by Pfeffer[16] in the case of the primary root of Vicia faba, where there was a considerable rise of turgor after the root was enclosed in a gypsum cast. This rise of turgor does not take place in all plants, as Pfeffer showed.

III. *The period between the formation of a cell and the arrival at its definitive condition is lengthened by an external resistance preventing or impeding growth.*

Under this general statement is included a group of phenomena the details of which may be the better emphasized by greater individual prominence, such as the following:

1. *The zone of elongation in roots and stems passes more slowly into its definitive length.*

2. *Differentiation of the fundamental parenchyma into collenchyma, sclerenchyma and sclerenchymatous parenchyma proceeds more slowly.*

3. *All the thick-walled and lignified elements of the bundles develop more slowly.*

It has already been stated that De Vries discovered this for elements of the xylem. The observations here recorded show that it holds true for the hard bast also.

4. *The formation of cork is deferred.*

This statement is in accord with the results obtained with the three plants under experiment and also with Gerber's[17] results in placing ligatures about stems. Since, as has been shown in this article and in the investigations of others, cells do not divide under pressure till they have reached or nearly

[15] Krüger: Ueber die Wandverdickungen der Cambiumzellen. Botanische Zeitung **50**: 663. 1892.

[16] Pfeffer: Druck-und Arbeitsleistung, 65.

[17] Gerber: Ueber die jährliche Kork-production im Oberflächen-periderm einiger Bäume. Inaug. Diss. Halle 1884.

reached their normal dimensions, and since cork-formation must be accomplished by extension and division of cells, it follows as a probability that cork-formation is delayed by pressure because of the mechanical resistance to cell-extension. But since cork-formation is attended by the death of externally lying cells, it is easily seen that soon after the formation of the phellogen, an external ligature or gypsum band will exert no immediate pressure in those cases where the phellogen is some distance within the periphery of the stem, simply because of the contraction of the dying tissue between the phellogen and the external ligature or band. Thus it seems probable that if external resistance is applied early enough to prevent the normal extension of the cells in which the phellogen usually appears, the formation of cork may be indefinitely postponed. If however the cells normally giving rise to the phellogen attain their full dimensions before the external resistance is applied we may expect the phellogen to be formed and cork-formation to proceed more or less slowly according to the greater or less vitality displayed by the cells external to the phellogen, and also according to the depth of phellogen within the cortex.

In this connection it is worth noting that Krabbe[18] found cork to arise deep within the cortex when a very great pressure was applied to the trunks of trees, this phenomenon being abnormal. This is certainly a regulatory act performed by the plant, but whether to regard it as a means of furnishing more room for the growth of the cambium cannot be decided with the lack of detail touching the accompanying phenomena as given by Krabbe. It may be mentioned however that Melianthus major, though the cork appears within an enveloping cast more tardily than outside of it, eventually frees itself completely from the resistance of the cast by the very act of cork-formation, the activity of the cambium from that time forward being usually great.

IV. *Under the pressure of a mechanical resistance cells reach their permanent condition with smaller size and thinner walls than normal.*

V. *Cells which usually die early have their life-period prolonged when their full extension or that of properly related adjacent cells is prevented by an external mechanical resistance.*

As appears from the narrative of the experimental part of

[18] Krabbe: Ueber das Wachsthum des Verdickungsringes, etc. l. c.

this article, the statement just made is founded principally on the behavior of the cells of the fundamental parenchyma. It was found in all cases where cells normally dying early were kept from reaching their full size that their life-period was extended. In certain cases also it was found that the pith of plants will live longer than usual if a gypsum cast is put around the stem after the pith has reached its full size, the cast, however, preventing the surrounding tissues of the stem from enlarging. It is probable that in the latter case, the pith lives because of the regulatory action of the plant, the usual more peripheral tissues not being formed, new duties are laid upon the pith. Such regulatory action accounts for the phenomenon discovered by De Vries[19] in Pelargonium zonale. In this case the flower axis bore among the flower-buds a vegetative bud which developed into a shoot, and the flower axis instead of withering as usual lived to function as a vegetative axis.

It is probable also that in the first group of experiments in which the cells were not allowed to reach their normal size that the same cause operated to prolong the life-period. Yet this was not in all cases the important cause. In the shoots of *Juncus* the cells remained alive though no greater demand was made upon them for transport of material nor for other function that can be thought of; the same could probably be said for the stems of Equisetum and the leaves of Allium enclosed in casts. In the case of the leaves of Allium when grown in darkness, we have the direct evidence that it is not the use of the central cells for purposes of transport that keeps them alive. In such cases it is probable the cells in question remain alive longer than normally because the conditions for their existence are not so unfavorable; that is, they live because the surrounding tissues are not allowed by their growth to pull these cells apart and thus bring them into unfavorable conditions. This question will be farther considered in a future article.

The experiments recorded in this paper have been scarcely extended enough in time to demonstrate the extension of the life-period of the elements of the fibrovascular bundle. That these elements also live longer than normally when surrounding tissues are not allowed to grow may be certainly inferred

[19] De Vries: Ueber abnormale Entstehung secundärer Gewebe. Jahrb. f. wiss Bot. **22**:—1891.

from the examples which all have noticed of vines twining about trees or of ligatures left unintentionally for years about trees. Since the elements of the bundle of woody plants normally live but a few years, it follows that beneath a ligature, such as those just mentioned, which has prevented radial extension in a tree for many years, the elements of the bundles must live longer than normally, otherwise we should have the whole zone dying and the stem above the ligature also dying.

VI. *If during primary or early secondary extension in a dicotyledonous stem, with pith of not great resistance, radial growth be prevented by external mechanical means, there will follow a displacement of the fascicular zone toward the axis of the stem, caused principally by the extension of the cortical cells. Later, however, the cortex will be crowded back by the growth of the fascicular zone.*

VII. *When an external pressure is great enough to prevent the derivatives of the cambium from attaining their normal size, the cambium will still continue to form new cells. This is an expression of the fact that the power of extension in the cambium is greater than that in derivatives of the cambium some distance removed from it.*

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New mosses of North America. V.

F. RENAULD AND J. CARDOT.

WITH PLATES XXI AND XXII.

Archidium Hallii Aust. var. **minus.**—Smaller than the type, from which it differs besides in the leaves shorter and the costa percurrent or shortly excurrent.

Louisiana: near Mandeville (*A. B. Langlois*, 1892).

Dicranella leptotrichoides.—Resembling in habit *Leptotrichum tortile.* Dioecious, small, loosely cespitose, green. Stems short, erect, simple, 2–5^{mm} long. Leaves erect or subsecund, lanceolate, acuminate, subacute or rather obtuse at the apex, quite entire, borders plane or partly revolute; costa stout, percurrent; cells of the areolation oblong or sublinear, shorter looser and subrectangular below. Perichaetial bracts scarcely different, a little longer. Pedicel 5–7^{mm} long, yellowish when young, afterwards reddish. Capsule small, erect, symmetric, ovate-oblong, scarcely constricted under the orifice when dry; lid equalling the sporangium, long and obliquely subulate-rostrate. Peristome purple, teeth trabeculate, striolate lengthwise, cleft to below the middle into 2–3 subulate legs, granulose and partly connected; annulus very broad, deciduous, of 2–3 rows of cells. Male plant unknown.

Louisiana: on slopes, Rivière Tchiffouté, Abita Springs, Covington, Fontainebleau near Mandeville (*A. B. Langlois*, 1891–1892). We have also specimens collected near Mobile, Alabama, by Sullivant, and distributed as *Trichostomum tenue.*

Closely allied to *D. Tonduzii* Ren. et Card. from Costa Rica; but distinguished by the leaves straight when dry and the areolation different.

Fissidens falcatulus.—Very small, gregarious, yellowish green. Stems rather rigid, plumulose, 2–4^{mm} long. Leaves 4–8 pairs, falcate-secund and rigid when dry, linear-lanceolate, acute or subapiculate; vaginant lamina about one-half length, narrowly bordered, dorsal lamina not bordered, tapering below, apical lamina without a border, subentire or minutely crenulate at the apex; costa pale, subpercurrent; areolation pellucid, cells hexagonal. Fruit unknown.

Louisiana: on bark of trees, Catahoulou, near Mandeville and bayou Alexandre (*A. B. Langlois,* 1890–1891).

Very near to *F. exiguus* Sulliv., from which it is distinguishable by the rigid habit, the leaves narrower and falcate-secund when dry, and the more pellucid areolation.

Physcomitrium turbinatum Brid. var. **crassipes.** (*P. Hookeri* var. *serratum* Ren. et Card. *Musc. Am. sept., p. 31*).—Pedicel short (4–6^{mm}), thick; capsule deoperculate, cup-shaped.

Oregon (herb. Lesquereux): Sandy river (*L. F. Henderson*), Willamette river (*Th. Howell*).

Bryum bimum Schreb. var. **atrotheca.**—Capsule black-red; leaves scarcely denticulate or quite entire at the point.

Newfoundland (*Rev. A. C. Waghorne,* 1892).

Timmia Austriaca Hedw. var. **brevifolia.**—Differing from the typical form by the stems shorter and the leaves more crowded, shorter and erect-imbricate, scarcely flexuous when dry.

Colorado: Springdale, Boulder Co. (*Marie Holzinger,* 1892. Comm. J. M. Holzinger).

Pylaisia polyantha Sch. var. **Coloradensis.**—Distinct from the type in the green tint and the cells shorter, very chlorophyllose.

Colorado: Springdale, Boulder co. (*Marie Holzinger,* 1892, Comm. J. M. Holzinger).

Brachythecium salebrosum Sch. var. **Waghornei.**—A peculiar form, distinguishable from the type by the tufts very dense, the stems erect, turgid, not radiculose, the leaves more crowded, imbricate, and the lid mamillate. Differs from the allied *B. mamilligerum* Kindb. in the leaves imbricate, not patulous when dry, and the stems not radiculose. Much smaller than *B. turgidum* Hartm.—Monœcious!

Labrador: Battle Harbor (*Rev. A. C. Waghorne,* 1891. Comm. Rev. C. H. Demetrio).

Brachythecium suberythrorrhizon.—Monœcious, intricate-cespitose, yellowish-green, facies of *B. velutinum.* Stems creeping, radicose, sparingly branching, branches procumbent. Leaves subhomomallous, oblong-lanceolate, long narrowly acuminate, bi–tri-plicate, sharply serrate all around; borders plane or partly revolute, costa vanishing above the middle, sometimes forked and shorter; areolation rather loose, pellucid, cells rhomboidal-linear, the alar quadrate, sub-obscure. Perichaetial bracts lanceolate, long acuminate-subulate, acumen serrate. Pedicel smooth, reddish, 10–12^{mm} long. Capsule suberect, turgid-ovate, not or scarcely constricted below the mouth when dry; lid unknown. Teeth of the peristome yellowish, triangular-lanceolate, segments narrow, split along the divisural line, cilia 1 or 2, long, filiform.

Colorado: Springdale, Boulder co. (*Marie Holzinger*, 1892. Comm. J. M. Holzinger).

Nearly allied to *B. erythrorrhizon* Sch., from which it differs in the narrower leaves and the looser areolation.

Brachythecium reflexum Sch. var. **Demetrii**. — Differs from the genuine form in the stronger habit, the thicker erect branches, and the broader softer leaves.

Labrador: Squaw Island (*Rev. A. C. Waghorne*, 1891. Comm. Rev. C. H. Demetrio).

Eurhynchium Sullivantii L. et J. var. **Holzingeri**.—Differs from the type in the branches shorter, generally obtuse, and the leaves broader and shorter acuminate.

District of Columbia: near Washington (*F. V. Coville*, 1889–1890. Comm. J. M. Holzinger).

Thamnium Holzingeri.—Green, slender, rather resembling in habit the small forms of *Isothecium myosuroides*. Primary stems creeping, stoloniform, secondary ascending or decumbent, more or less shrub-like, pinnate, branches complanate, generally attenuate. Lower stem leaves small, erect-spreading, from a broadly deltoid base ligulate-obtuse; costa vanishing about the base of the acumen; upper leaves larger, distichous, complanate, slightly asymmetric at the base, oblong-ligulate, obtuse or subobtuse, costa vanishing far from the apex, sometimes forking above; branch leaves smaller, with the costa shorter and the lower margin inflexed, the upper leaves acute; all the leaves plane and crenulate-serrate on the margins, coarsely and irregularly dentate at the apex; areolation parenchymatous, cells incrassate, short, chlorophyllose, roundish or subhexagonal above, ovate or oblong in the middle, sublinear below, the alar small, rather obscure, subquadrate or roundish. Inner perichaetial bracts subvaginant, oblong-lanceolate, long loriform-acuminate, serrulate, costa thin, cells narrower; vaginule covered with numerous long paraphyses. Pedicel smooth, reddish, short ($6–9^{mm}$). Capsule erect, oblong, subsymmetric, constricted under the orifice when dry, lid conic, obliquely beaked. Teeth of the peristome yellowish, lanceolate-acuminate, subulate, segments narrowly split along the divisural line, cilia 2, long, nodose. Seems to be diœcious.

Oregon: Myrtle Point, Coos co. (*Rev. G. A. Holzinger*, 1892. Comm. J. M. Holzinger).

This fine little moss cannot be confounded with any other North American or European species. It rather resembles some small tropical species of the genus *Homalia* and *Porotrichum*, but is easily distinguished from these by the perfect peristome, with long cilia.

Amblystegium Holzingeri.—Loose, green or yellowish green. Stems depressed, irregularly branching. Leaves very loose, distant, patulous, ovate-lanceolate, broadly and obtusely acuminate, quite entire; costa generally simple, thin, vanishing above the middle, sometimes forked and shorter. Areolation rather loose, cells oblong or linear, flexuous, with the primordial utricle distinct, the alar shorter, looser. Perichaetial bracts oblong-lanceolate, acuminate, very entire, costate, more narrowly reticulate. Pedicel short, 6–8^{mm} long, reddish. Capsule inclined or subhorizontal, small, ovate, arcuate, much constricted below the mouth when dry, lip depressed, obtusely apiculate.

Virginia: bank of Potomac. District of Columbia: Rock Creek. (*J. M. Holzinger*, 1891–1892.)

Allied to *A. adnatum*, but easily distinguished by the short-acuminate and obtuse leaves, the generally simple costa, the looser and less numerous alar cells, the shorter capsule and the more depressed lid.

Hypnum giganteum Sch. var. **Labradorense.**—A notable variety, distinct from the type by the leaves larger and longer and the costa attenuate, vanishing rather far from the apex and often forking.

Labrador: Battle Harbor (*Rev. A. C. Waghorne*, 1892).

Vesoul and Stenay, France.

EXPLANATION OF PLATES XXI AND XXII.

All the figures magnified are drawn by means of Nachet's camera lucida.

PLATE XXI.—**A.** *Dicranella leptotrichoides.* *a*, entire plant; *b*, *b*, leaves; *c*, areolation of the basal borders of the same; *d*, do. in the middle; *e*, capsule with the lid; *f*, capsule deoperculate; *g*, portion of the annulus; *h*, two teeth of the peristome.—**B.** *Fissidens falcatulus.* *a*, entire plant; *b*, upper part of a stem; *c*, *c*, leaves; *d*, apex of a leaf; *e*, areolation of the margin of the vaginant lamina.—**C.** *Amblystegium Holzingeri.* *a*. entire plant; *b*, *b*, *b*, *b*, leaves; *c*, alar cells; *d*, areolation in the middle; *e*, *e*, areolation of the apex; *f*, capsule operculate; *g*, the same deoperculate.

PLATE XXII.—**A.** *Thamnium Holzingeri.* *a*, entire plant; *b*, portion of a branch; *c*, *c*, lower stem leaves; *d*, *d*, upper stem leaves; *e*, branch leaves; *f*, apex of a stem leaf; *g*, apex of a branch leaf; *h*, alar cells; *i*, areolation on the margin, in the middle; *j*, areolation of the apex; *k*, inner perichaetial bract; *l*, capsule with the lid; *m*, portion of the peristome.—**B.** *Brachythecium suberythrorrhizon.* *a*, entire plant; *b*, *b*, *b*, leaves; *c*, alar cells: *d*, *d*, point of the same; *e*, capsule deoperculate; *f*, leaf of *B. erythrorrhizon* Sch.

Notes on Richardia Africana.

ERNEST WALKER.

Of the many abnormal "flowers" of Richardia Africana which have come under the writer's observation the most interesting departure from normal structure yet seen made its appearance a short time since in one of the green-houses among a lot of several hundred "callas."

In this monster the spathe and spadix while developing in the manner of an ordinary inflorescence were found at maturity to be independent, or disunited, and each on a stalk of its own.

The spathe was somewhat larger than usual, more spreading, and not at all convolute at the throat. Its stock or petiole was sheath-like from the spathe down to the base and clasped the scape which supported the bractless spadix almost in the same manner that the petiole clasps an ordinary "flower" stalk.

The white color and texture of the spathe extended for some distance down the free wavy margins of the petiole.

The spadix was normal otherwise except in having fewer ovaries than usual. At first it occupied the ordinary position in the spathe; but after a few days, owing to continued growth of its scape, it became elevated 4^{cm} above its usual position.

There was a coadnation at the base of the scape and petiole for 9^{cm} upward, but this involved only the posterior wall of the sheath while the anterior edges were free.

This self-analyzed inflorescence makes clear the morphological structure of the Richardia flower and peduncle. One writer has explained the scape as made up of "several leaf-stalks grown together in a bundle," but it now is evident that only one leaf is involved. The spadix is at the summit of a single much elongated internode of rhizome, to which in the normal inflorescence the sheathing leaf-stalk is adnate.

In the spadix itself there is complete suppression of bractlets to which the flowers are, however, theoretically axillary. Even keeping this in view it is not necessary to regard the scape as involving a number of leaf-stalks in its structure since if bractlets existed they would more likely be stalkless appendages rather than the free tips at the summits of long theoretical petioles.

This "flower" had a good opportunity to fertilize itself if this had been possible. In the hope of getting it to seed the stigmas were hand pollinated after about the third day. But in vain. After about three weeks the ovaries had developed considerably and attained about half size. Then they stopped growing and the spadix began to shrivel. The spathe withered earlier.

This result and experiments with several other plants convinced the writer that the flowers are proterogynous. Examination showed that the stigmas were receptive of pollen about three days before the pollen of the same spadix begins to fall, and when the pollen appears the stigmas are much shrunken.

Four flowering plants were set aside, and with due precautions, left to fertilize themselves. Although the ovaries began development they withered when about half grown. The "calla" is said rarely to produce seed in the green house. We now have in its proterogyny, the explanation.

The spathe is a specialization looking to cross fertilization, although its convolute and funnel-like base at first might seem nicely adapted for catching the pollen and bringing about self fertilization. It is likely this occurs, however, in Araceæ just in proportion as the spathe is reduced and the individual flowers on the spadix become hermaphrodite and complete.

In the Richardia there are on most of the older and larger leaves two gland-like bodies at the summit of the petiole where the basal lobes of the lamina join the leaf stalk. They look as if they might be nectar glands; but they are probably merely thickenings to strengthen the blade against tearing, when the plants are growing in running water, and occasionally submerged, as is the case in their native land.

While engaged in these observations it occurred to me to investigate the manner in which the pollen is forced out through the minute pores.

The anthers are almost sessile somewhat cuboidal bodies. Wood's "Class book" gives them as two-celled, but the cells being bilocellate they may be called four-celled. The locelli are vertical, oblong, thin-walled, and confluent above into a single tube, terminating in a minute pore through which the pollen is pressed.

The discharge of the pollen was found to be brought about by pressure caused by the gradual enlargement of the connective. In a young anther the connective is delicate and thin, making up about one-third the width of the anther. In old anthers it composes about two-thirds of the width, having become broad and plump as the cells decreased in size from the loss of their contents. All this takes place without any appreciable change in the size of the anther as a whole. The connective thus acts like a wedge between the cells. The sessile anthers being much crowded, growth of the connective results in a mutual pressure between the cells of one anther, and those of its neighbor.

The grains of pollen are smooth walled and slippery with mucilage, so under the pressure readily escape through the small pore. While within the cell the grains are semi-translucent but on escaping they become opaque white. The mucilage moistening their surface causes the grains to adhere together as they escape. Consequently the pollen is found in filamentous form. This is evidently with reference to transportation by some kind of living agent.

It is noticed that the summit of the anther through which the discharge tube leads is transversely thickened and quite firm. This is for the purpose of preventing rupture of the pore, and securing the discharge of pollen in the form of a filament, instead of a mass as would be the case were it not for the precaution nature has taken.

On cutting off the summit of the anther the relief to pressure results in the immediate discharge of the pollen in the form of cylindrical masses as large as the diameter of the locelli. Thus it is seen the contents of the anther cells are subjected to a considerable pressure, as necessary to secure the discharge of the pollen in the form of filaments as seen in the normal anther.

New Albany, Ind.

BRIEFER ARTICLES.

Olpitrichum, a new genus of mucedinous fungi.—WITH PLATE XXIII. —Among the fungi which are active in hastening the rot of the carpellary tissues of the fruit of *Gossypium* in the United States, when the cotton is mature and during wet weather, are several mucedinous fungi which are attractive from the whitish or dirty buff color of the loose mass of threads and spores. Two of these which are quite common are members of the genus *Rhinotrichum* Corda. They occur either separate or intermingled on the same boll. *R. macrosporum* Farlow is, perhaps, the more common of the two and is quite frequently of a sordid buff color and can thus be provisionally separated from the other species, *R. tenellum* B. & C., at times, before examination with the microscope. These two species are quite common in the vicinity of Auburn, Alabama, and I have found them in several other parts of the state.

When visiting Brundage, Ala., for the purpose of inspecting the condition of the cotton in that region, I collected a fungus on the bolls which I took upon superficial examination to be *R. tenellum*, from the fact that it resembled this species in color. It proved to be very different however, and the character of the basidia clearly separates it from the genus *Rhinotrichum*.

In *Rhinotrichum*[1] the sterile hyphæ are creeping, the fertile ones erect, their ends being denticulate to spiculigerous, the spores being borne on these acicular sterigmata. In this new genus, for which I propose the name *Olpitrichum*, instead of the ends of the fertile hyphæ being denticulate or spiculigerous, they bear well developed flask-shaped basidia, which are scattered over the surface of the terminal portion of the hypha, or are clustered irregularly or in rosettes. The genus may be characterized as follows:

Olpitrichum gen. nov.—Saprogenous. Sterile hyphæ creeping, septate, branched; fertile hyphæ erect, simple or little branched, septate. Near the apex provided with flask-shaped, fusoid, or enlarged basidia, irregularly scattered or gregarious, which may be branched or become proliferous, each bearing a single spore. Conidia ovoid-oblong, hyaline or pale colored. It is *Rhinotrichum* but with inflated basidia which are constricted at the point of union with the hypha. It bears much the same relation to *Rhinotrichum* that *Pachybasium*[2] does to *Verticil-*

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[1]Corda, Icones Fung. **1**: 17. Saccardo, Syll. Fung. **4**: 91.
[2]Saccardo, Fung. Alger. Tahit. Gall. 6.—Syllog. Fung. **4**: 149.

lium. The basidia resemble somewhat those of *Cylindrodendrum*,[3] are less regular in form, while those of *Cylindrodendrum* are subopposite and sometimes whorled, and the conidia are strictly cylindrical.

Olpitrichum carpophilum sp. nov.[4]—Effuse, whitish. Fertile hyphæ hyaline, 3–7-septate, 90–180 × 4–6μ. Basidia flask-shaped or fusoid scattered, or grouped irregularly or in the form of rosettes, 10–15× 3-6μ. Conidia ovate or sometimes oblong or broadly elliptical, frequently with a minute apiculus at the base, hyaline, 25–30 × 16–25μ, or 16–25μ in diameter. On decaying carpels of *Gossypium herbaceum*, Brundage, Ala., Sept. 1891.

The characters of *O. carpophilum* are shown in plate XXIII, figures 1 to 4. *Rhinotrichum macrosporum* Farlow and *R. tenellum* B. & C. are also represented in the same plate. The spores of *R. macrosporum* Farl. measure 15–30 × 10–20μ, and those of *R. tenellum* B. & C. measure 6–12 × 10–20μ. The ends of the fruiting hyphæ or their branches are somewhat enlarged and denticulate or spiculigerous in *R. tenellum*. —GEORGE F. ATKINSON, *Botanical Department, Cornell University.*

EXPLANATION OF PLATE XXIII.—Figs. 1–4, *Olpitrichum carpophilum* Atkinson.—Figs. 5–8, *Rhinotrichum macrosporum* Farlow. Figs. 9–13, *R. tenellum*, B. & C. Figs. 4–7, 9–13 drawn to the same scale; 1–3, 8, and 14 drawn to the same and a higher scale.

Notes on germinating myxomycetous spores.—The paper upon the germination of spores of *Enteridium Rozeanum*, by E. J. Durand, in the March number of the GAZETTE, suggested to me that possibly my own experience was worthy of record.

In the early part of April, 1893, I brought in a specimen of *Reticularia umbrina* Fries. As soon as it was mature, five days later, spores were placed in ordinary drinking water, and in a few hours were found to have germinated. Further experiments showed that some spores germinated within from fifty-five to sixty minutes. Within ninety minutes one-tenth of the spores usually germinated, and few germinated later. The swarm cells remained active several days in the moist chamber. During the past year the spores of this and other specimens of Reticularia umbrina have been frequently germinated in my laboratory by different students, no difficulty ever having been experienced. By placing a quantity of the spores in some distilled water in a watch glass, millions of the swarm-cells will appear in an hour or two and form a conspicuous white layer, with the ruptured epispores and ungerminated spores as a substratum.

[3] Bonorden, Handbook.—Cornu, Reproduction des Ascomycetes, etc., Ann. d. Sci. Nat. Bot. VI. 3: 53. *pl. 9. fig. 12.*

[4] This fungus appeared in the exhibit of the Agr. Dept. at the World's Fair, Chicago, 1893, among the diseases of cotton from Alabama, under the provisional name *Rhinotrichum macrosterigmatum* Atkinson, which name was never published.

In April of this year I collected a fresh specimen, and germinated spores from it side by side with spores from the specimens then a year old. I found that, as before, about one-tenth of the spores from the fresh specimen germinated, while one-third to one-half of the year-old spores germinated. The swarm-cells from the latter seemed to possess more vitality also, remaining alive in distilled water longer than the swarm-cells from the fresh spores. Very few of the latter were found active at the end of twenty-four hours. There was little difference in the time required for the germination of the two. The temperature was always that at which the air of the laboratory happened to be, no attempt ever having been made to keep the spores at any given temperature.

The diameter of the spores is about 8μ, of the amoeboid cells about 7μ, and of the swarm-cells about 6μ. Only uniciliate swarm-cells were observed.

I have also germinated year-old spores of *Diachaea leucopoda* Bull., *Hemiarcyria rubiformis* Pers., and *Fuligo septica* (Fries) Link., and spores of *Badhamia hyalina* Pers. two months old. Only a small percentage of any of these germinated, but the time required was less than three hours for any of them. Only amoeboid cells of Hemiarcyria rubiformis were observed. In all cases about one-half hour was consumed by the protoplasm in escaping from the epispore, and the time given above as the time required for germination is that between the moment they were placed in water and the moment the protoplasm assumed the swarm-cell form.

It will be seen that my experience agrees more closely with that of De Bary[1] than that of Durand. The time required for the germination of some of the spores is shorter, however, than that of which I find any record. I am indebted to A. P. Morgan for the determination of the specimens mentioned in this article.—ALFRED JAMES MCCLATCHIE, *Biological Department, Throop Polytechnic Institute, Pasadena, Calif.*

Sphaeroplea annulina (Roth.) Ag. **in Minnesota.**—This interesting alga has been previously reported from California by Dr. W. G. Farlow, upon the basis of collections by Mrs. Austin near San Bernardino [2] and so far as known to me this is the only authentic report of its occurrence in the United States. Wolle,[3] whether from a doubt concerning the identification or failure to note the definite terms of Dr. Farlow's announcement, states that "it is reported from Califor-

[1] De Bary, Comp. Morph. and Biol. of Fungi, etc. (Eng. trans.) 421 and 448. 1887.

[2] Farlow, W. G., Notes on fresh-water algæ. Bot. Gaz. 8: 224. 1883.

[3] Wolle, freshwater algæ of the United States. 104. 1887.

nia but without certain knowledge as to locality." This hesitant inclusion is apparently the basis of the doubtful attributing of Sphaeroplea to America by Wille [3] in his monograph upon the family, but the true state of the matter is shown clearly enough by Magnus [4] in a brief note upon the distribution of the plant, published in *La Notarisia.* There need be no further question, however, about the presence of this plant in the United States, since it was collected in quantity by Mr. D. T. MacDougal and myself, in inundated meadows near Bass lake, Hennepin county, Minn., April 23, 1894. The filaments were intermingled with those of Zygnema and Spirogyra and were found to include all stages of development. The formation of sperms, eggs and syngametes was noted and apparently at least two of the varieties recognized by De Toni [5] were present in the material studied. A further contribution may be looked for from the Minnesota laboratories upon this plant.—CONWAY MACMILLAN.

[3] Wille, N., Sphaeropleaceæ in Engler and Prantl. Nat. Pflanzenfam. Theil I. Abth. 2. June, 1890.

[4] Magnus, Paul, Nuova contribuzione alla conoscenza dell' area geografica della *Sphaeroplea annulina* Roth. La Notarisia **6**: 1215. 30 Ap 1891.

[5] De Toni, Sylloge Algarum. **1**: 95. 25 Jy 1889.

EDITORIAL.

A CORRESPONDENT takes the GAZETTE to task in this wise: "It appears to me that the GAZETTE contains too many articles that ought not to appear in print. . . . I would especially call attention to Mr. ——'s paper upon ——, and Mr. ——'s upon ——. These articles are too defective for the GAZETTE and do not add anything to our knowledge, but contain numerous poor statements of well-known facts."

We do not undertake to defend these papers, whose defects were fully recognized by the editors; or to set forth the reasons, to us sufficient, for accepting them for publication. We content ourselves with saying that we conceive it to be the duty of the GAZETTE to reflect as correctly as possible in papers published the state of investigation in the United States, and to urge (as we have repeatedly done and now do again) the necessity of increasing care in the preparation of papers offered for publication. It must be remembered that such criticisms as the above weigh chiefly against the authors. They do themselves discredit by the publication of any paper for which there has not been a careful consultation of all previous investigations along the same line, and at the same time tend to bring into disrepute, *prima facie*, all American investigators.

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THE STATE OF THINGS described so forcibly in Professor Koehne's reply to criticisms upon the *Botanischer Jahresbericht* is highly discreditable to botanists. We are glad to have the facts brought to notice, however, for we hope that a knowledge of them will work the desired reformation. It is really marvelous that under such difficulties the *Jahresbericht* is published as promptly and is as complete as it is. We think the editor and his staff deserve the warmest thanks and highest commendation of the hundreds who have profited by their labors. We have been wont, heretofore, to excuse American botanists for carelessness in sending separates, but in the light of Professor Koehne's letter further failure will be inexcusable. Reader, if you write anything botanical for scientific journals, sit down quickly and enter Professor Koehne's address in your mailing list. We are glad to say that the BOTANICAL GAZETTE has long been one of the twenty journals which go regularly to the *Jahresbericht*.

CURRENT LITERATURE.

Minor Notices.

THE SECOND VOLUME[1] of biological lectures delivered at the marine biological laboratory of Woods Holl has recently appeared, the first volume having appeared in 1890. Ten lectures are included, all given by investigators upon subjects connected with their own work, and all presenting current problems. It would be impossible to review a work made up of so many important and independent parts, and where each part is the compact presentation of a large subject. It is sufficient to indicate such titles as are of botanical or general biological interest, and to state that this collection of lectures is one that every student of biology should read. The botanical and biological titles are: The mosaic theory of development, E. B. Wilson; The fertilization of the ovum, E. G. Conklin; On some facts and principles of physiological morphology, J. Loeb; Dynamics in evolution, J. A. Ryder; On the nature of cell organization, S. Watasé; The inadequacy of the cell-theory of development, C. O. Whitman; The influence of external conditions on plant life, W. P. Wilson; Irrito-contractility in plants, J. M. Macfarlane.

THE PROCEEDINGS of the Indiana Academy of Sciences for the year 1892 have been issued and recently distributed. They form a creditable volume of 169 pages and two plates. The botanical part embraces seventeen papers given by title only, and nine given in full or nearly so. The latter are: Grinnellia Americana, by M. A. BRANNON; Botanical field work in western Idaho, by D. T. MACDOUGAL; The application of mathematics in botany, by KATHERINE E. GOLDEN; Notes on certain plants of southwestern Indiana, by JOHN S. WRIGHT; Epidermis and spines of Cactaceæ, by E. B. ULINE; The genus Cactus, by E. M. FISHER; An auxanometer for the registration of the growth of stems in thickness (with plate), by KATHERINE E. GOLDEN; Notes on Pediastrum, by W. L. BRAY; and The Lilly herbarium and its work, by JOHN S. WRIGHT.

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[1] Biological lectures delivered at the marine biological laboratory of Woods Holl, in the summer session of 1893. Large 8vo. pp. 242. Ginn & Co., Boston. 1894.

OPEN LETTERS.

A defense of the Botanischer Jahresbericht.

The criticisms uttered by Mr. J. Christian Bay in the December number of the BOTANICAL GAZETTE (18: 471–472. 1893) require an answer on the part of the editor of the *Botanischer Jahresbericht*. This answer must, above all, urge the incredible want of interest the greatest part of botanists take in the *Jahresbericht*. Indeed, the *Jahresbericht* mentions about 7,000 botanical writings every year, and what is the number of separates sent to the editor? 270–280 a year! The number of periodicals to be reviewed every year is certainly more than 1,000, and what is the number of periodicals the editor is presented with? About twenty! And Mr. Bay says: "A work of this kind ought not to rely *only upon donations!*" *Only!* It would be laughable were it not too painful. Mr. Bay will see from these data, that the editor, as well as his staff of collaborators, is relying a good deal upon "books and papers, which could be bought or otherwise promptly secured." The editor is not enabled to buy more than he does, for the botanical world neglects the *Jahresbericht* in still another manner: nobody buys it. There is a small number of public libraries, institutes and laboratories which acquire the *Jahresbericht* regularly, but private subscribers might be counted upon the fingers. Now, I ask Mr. Bay, whence should be secured the means for buying numerous periodicals not to be secured otherwise for the *Jahresbericht?* From the publishing bookseller? He is content with seeing his expenses barely reimbursed. From the editor? He lives with his family from his allowances as a teacher at a public school and does his work for the *Jahresbericht* for scientific, not for pecuniary interest, so that his work does not enable him to buy costly books and periodicals in a greater number. The same is to be said for the collaborators. They all stick to their work in the most disinterested manner, and sacrifice for the *Jahresbericht*, and consequently for botanical science, more time and labor than most botanists have any idea of. So I have to say to Mr. Bay: If botanists would buy the *Jahresbericht*, the editor might be enabled to secure more books or periodicals by buying, or by exchanging, though the *Jahresbericht* is much higher in price than most publications to be exchanged for it.

But, it must be added, periodicals are not what the *Jahresbericht* wants. It wants more separates. Many periodicals must be sent by the editor to half a dozen or to a dozen collaborators. So, a series of periodicals goes from Berlin to Luckenwalde; then, in due time, from Luckenwalde back to Berlin. After this, the editor has to prepare another set of books for Karlsruhe. Having got it back from Karlsruhe, he sends a third packet of new composition to Innsbruck, etc., etc. What enormous loss of time! It is impossible to allow the books to circulate among the collaborators, for the editor would need, in this case, to prescribe a peculiar course for every book, one book being destined for the collaborators A, B, C, D, E, the second for A, C, E, F, the third for B, D, F, G, etc., etc., and, moreover, the editor would lose all control. As to the collaborator reviewing periodicals in the libraries of his residence, he will spend a great deal of time in paying numerous visits (partly vain, partly successful) to the libraries. So his labor is immensely enlarged, the time he needs for finishing his report increases in a very troublesome manner. The *Jahresbericht* is published much later than the editor himself and the botanical world desire. This would all be changed if the botanists of all countries would think of sending their publications directly to the editor. These writings might then be distributed immediately among the collaborators, and these might work out the greatest part of their reports in their studies, with an invaluable gain of time, so that the *Jahresbericht* might be published more promptly. What a difference, for instance, for the bacteriological collaborator to have—as indeed he has—*one to three* separates every year from the authors themselves by the intervention of the editor, and to search for the rest of the bacteriological writings in several hundreds of periodicals,—or, as it ought to be, to have some hundreds of separates from the bacteriologists themselves! The *time* allowed every year for working off the extensive *Jahresbericht* is a factor Mr. Bay has entirely overlooked. The editor sets a greater value on the appearing of the *Jahresbericht* in due time than on its absolute completeness, and he is of opinion that a botanical author himself has a still greater interest in seeing his writings publicly known than his fellow botanists and the editor of the *Jahresbericht* have. Nevertheless, most botanists will do nothing at all for spreading abroad their articles, but depend entirely on the staff of the *Jahresbericht* or of other periodicals of similar character.—E. KŒHNE, *Friedenau bei Berlin, Kirchstr. 5.*

On compass plants and twisting of leaves.

If it be permitted, I would like to present a few remarks concerning the nature of the torsions in the leaves of the so-called compass plants. These torsions were described as twisting by Mr. Meehan (*supra*, pp. 158–159). The leaf-movements in the compass plants are, for good reasons, interpreted as heliotropical torsions. Now, Mr. Meehan states that these torsions result from "a somewhat prolonged effort of spiral growth."

Mr. Meehan has, evidently, confounded different movements. Having had some experience with compass plants, I shall be ab'e, I think, to explain Mr. Meehan's results. The question is very simple, and belongs to the elements of vegetable physiology.

I. Compass plants. Experiments (the literature was given in my article on this subject in the Deutsche Botanische Monatsschrift 11: 1. 1893) have demonstrated that (1.) The vertical position of the leaves is assumed only when the plant is growing fully exposed to the sunlight. (2.) When the plant is growing in the shade, the leaves assume the fixed light-position. (3.) When the plants are so situated that they receive only the oblique rays of either the morning or the evening sun, the leaves place their superior surfaces at right angles to the incident rays. (4.) When the plants are under such circumstances that they receive the sun's rays only when the sun is high in the heavens, the leaves present their superior surfaces to the incident rays.

These results certainly indicate that the torsions are physiological. I think that Mr. Meehan's observations are very easily and simply explained from what we know of the relations of heliotropism to growth, which has been established mainly by De Vries, Müller-Thurgau, Ch.

Darwin and Wiesner (Die heliotr. Erschein. 1878–80), namely, that *heliotropic movements may become fixed by growth.*

That growth is rhythmic, and not continuous was known already to Ingenhouss and Th. de Saussure. We know that "growths that start together" are by *no* means likely to rest together, for although the question of individual differences has never been much studied, we are, in our studies, always troubled with individual variations.

The cause of the polarity is light; polarity may be changed, in *growing* leaves, into the fixed, normal light-position, when surroundings are changed; *grown* leaves will continually stay in the position of polarity. All that is needed to demonstrate this is a couple of drain pipes.

II. The twisting of leaf-blades was investigated by Wichura (Flora, —: 33. 1852.); since which time, these movements have not been much studied.

In monocotyledons, torsion of the leaves to the right takes place, when the scape is leaf-bearing, otherwise the leaves twist to the left. The list following shows some observations which I made in 1889.

Torsion to the right occurs in Allium (some); Bromus; Triticum; Secale; Hordeum. Torsion to the left occurs in Fritillaria; Allium (some); Festuca; Avena (upper leaves).

It has never been proved that growth is the primary cause of these movements, for an elimination of heliotropism by means of the clinostat has never been made. The twisting of leaves in Gramineæ is of much systematic value, and says ten times more than a thousand synonyms in a description.—J. CHRISTIAN BAY, *Des Moines, Iowa.*

"Minnesota Botanical Studies."

As editor of *Minnesota Botanical Studies* I regret that my selection of articles for its pages should, even in a single case, fail to meet with the approbation of Mr. F. V. Coville. My collaborateur is good enough not only to offer some useful statements of personal opinion, for which he has our thanks, upon certain debatable questions considered by Mr. E. P. Sheldon in a recent paper, but also to convey to me, through the GAZETTE, suggestions concerning what I may not without impropriety publish in the special journal entrusted to my care. Perhaps I may venture to note that *Minnesota Botanical Studies* does not hope to say the last word upon any of the matters touched upon in its columns. It is the opinion of the editor that even such preliminary contributions as he understands Mr. Coville to condemn are of value to him in the prosecution of the work he has in hand.

So far as *Minnesota Botanical Studies* is concerned, since it is supported by a Minnesota enactment, since it is a Minnesota work that it principally desires to do and since it is the wish of the editor that it be sent without price to whoever might be supposed to care for it, I hope no one will feel defrauded if some of its articles, from his broadly national point of view, seem too local and of too restricted interest for publication.

In the case in hand, while Mr. Coville's opinion of what the Minnesota survey should publish at a given moment and what it should retain in manuscript and how these manuscripts should be used, is of interest, I trust he will pardon me for suggesting that even the most unusual critical powers may be in danger of deterioration if dissipated over too wide a territory.—CONWAY MACMILLAN, *Minneapolis.*

NOTES AND NEWS.

IT IS ESTIMATED that forty per cent. of honey dew, as it occurs upon the leaves of trees, consists of the rare sugar, melezitose (Comp. rend. 117: 127).

ARTEMISIA STELLERIANA Bess. occurs at Little Compton, and Newport, R. I. In this connection an article in the March number of Journal of Botany should be read.—BAILEY.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will meet this year in Brooklyn, August 16th to 22d. Announcements may be obtained from the local secretary, Prof. Geo. W. Plympton.

DURING THE coming summer Professor John Macoun intends to collect in the prairie region of Canada. These constant explorations are bringing to the Government Herbarium a fine representation of our northern flora.

DR. G. A. WEISS, Professor in the University of Prag, and director of the School of Vegetable Physiology, died March 17, aged 57 years. Dr. Hans Molisch has been called to fill the position made vacant by the death of Dr. Weiss.

TEACHERS OF botany may be interested to know that *Negundo aceroides* shows a beautiful set of gradations through scales to true leaves. In the figure in Gray's Genera, vol. ii, their transition is only partially shown.—BAILEY.

MR. MERRITT FERNALD expects to publish shortly an appendix to his Name Catalogue, containing a record of work during the last two years. Nearly a hundred flowering plants have been added to the list, many of them of very great interest.

HEFT THREE of the *Berichte der deutschen bot. Gesellschaft* contains the following papers: R. Lauterborn, Concerning the locomotory movements of diatoms, with reference to O. Müller's papers on the same question (*Berichte*, 11: 571 and 7: 169); P. Taubert, On the occurrence of the genus *Physostigma* in Eastern Africa, and on some of its morphological peculiarities; P. Magnus, On some parasitic fungi of the Mediterranean territory.—BAY.

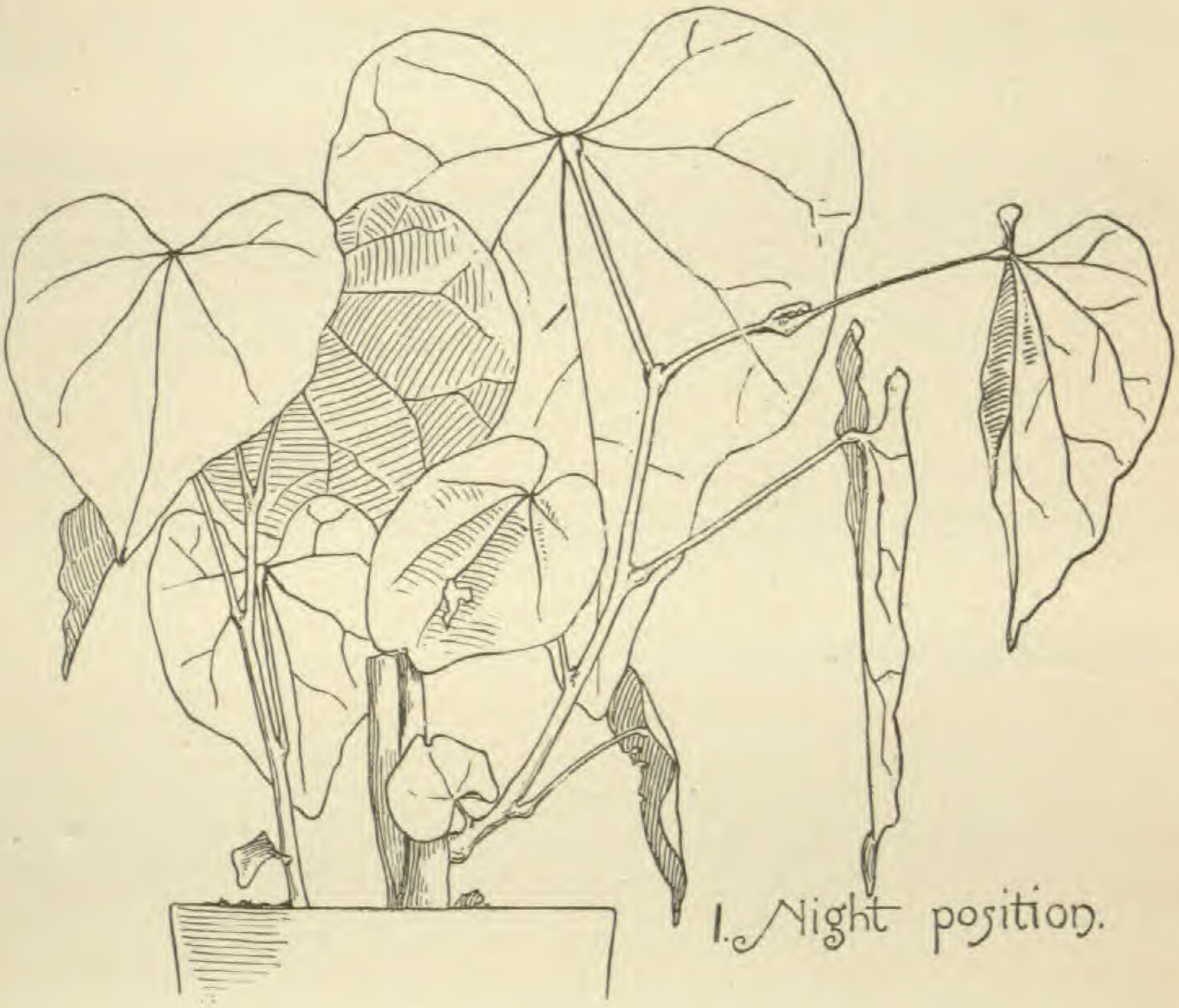
THE BOTANICAL DEPARTMENT at Brown University partakes of the general "boom" of the institution. Over 120 students have taken the course this year. The old laboratory, now too small for general classes, is newly fitted up for histological work. The larger classes have to hear lectures where they can. Much valuable apparatus has been added, and excellent work is being done. Mr. Osterhaut, besides being assistant here, acts in that capacity at Woods Holl, in summer, where he always sent a number of students.—BAILEY.

MR. S. E. CASSINO, the Boston publisher, having received requests from many persons to issue a directory of naturalists arranged by specialties or departments of study, and from others who desire a geographical arrangement, has decided to publish such a directory of the United States and Canada, provided a sufficient number of subscriptions are received to warrant the undertaking. The names will occur in triplicate, alphabetically, geographically and by departments of study. If possible, the work will be issued in December of this year or early in January, 1895.

UNDER THE AUSPICES of the Belgian government, an international congress of scientists who are interested in the progress of applied chemistry will be held at Brussels from August 4th to 12th. There will be a section of agricultural chemistry which will consider nine important questions, some of which are most closely related to vegetable physiology. There will also be a section of biological chemistry which will have under consideration some questions concerning yeast. Professors H. van Laer and J. Vuylsteke are at the head of this section. Steps will be taken to publish a Review of biological chemistry in several languages. Papers may be read by the author or sent to the secretary, Prof. H. van Laer, 15 rue de Hollande, Brussels.—BAY.

THE MARINE BIOLOGICAL LABORATORY at Woods Holl, Mass., will be open for its seventh season from June 1 to August 30, 1894. The officers of instruction in Botany are W. A. Setchell, Instructor in Botany, Yale University, and W. J. V. Osterhout, Instructor in Botany, Brown University. The laboratory for teachers and students of Botany will be open from July 11th to August 18th. The laboratory work will be restricted to the study of the structure and development of types of the various orders of the cryptogamous plants, especial attention being given to the study of the various species of marine algæ, which occur so abundantly in the waters about Woods Holl. Applications should be addressed to William A. Setchell, 2 Hillhouse avenue, New Haven, Conn.

THE ANIMAL FOOD of Utricularia vulgaris has been carefully examined for plants growing in the Gullane ponds near Aberlady, Scotland, by Mr. Thomas Scott, of the Fishery Board for Scotland, assisted by his son (*Annals of Scottish Nat. Hist.* —: 105–112. 1894). No utricles were included less than one twelfth inch in greatest diameter. Of the first lot of 500 utricles taken from the plants at random eighty-one contained no organic matter, thirty-five contained organic matter too much decomposed to identify, and 384 contained recognizable organisms. The record is given in detail, but only the summary can be noted. In the 384 utricles were 1415 Cypris (mostly of two species), 535 Cyclops (nearly 90 per cent. being males), and seventy-one other minute animals, or an average of over five organisms to each utricle. After some weeks another lot of 300 utricles were examined with closely similar results. Five pieces of stem of Utricularia of an average length of six and one half inches were found to bear 1531 utricles, of which 1371 contained organic matter. According to the above average this would give over 7,000 organisms captured by these five short stems. A tow-net examination of the pond water showed no unusual abundance of minute animal life. Such plants must be powerful enemies to the active pond life. Several related questions are also considered by the authors, such as the reasons for a different proportion between the kinds of organisms inside and outside of the utricles.



1. Night position.

2. Day position.

WRIGHT on CERCIS.

WRIGHT on CERCIS.

RENAULD and CARDOT on NEW MOSSES.

RENAULD and CARDOT on NEW MOSSES.

ATKINSON on OLPITRICHUM, gen. nov.

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THE

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Missing Numbers.—Will be replaced *free* only when claim is made within 30 days after receipt of the number following.

[Entered at the Post-office at Madison, Wis., as second-class postal matter.]

In the August number will appear:

James Logan, an early contributor to the doctrine of sex in plants, by DR. JOHN W. HARSHBERGER, *Philadelphia, Pa.*

Descriptions of new species of Uredineæ and Ustilagineæ, with remarks on some other species, by DR. P. DIETEL, *Leipzig, Germany.*

Crystals of ice on plants, by J. CHRISTIAN BAY, *Des Moines, Iowa.*

A preliminary synopsis of the North American species of Amaranthus, will be concluded.

Theo Mez ad nat. del.

B. Meisel, Lith. Boston.

PHOEBE AMPLIFOLIA, Mez & Donnell Smith.

Theo Mez ad nat. del.

B. Meisel, Lith. Boston.

NECTANDRA HEYDEANA, Mez & Donnell Smith.

GYMNOGRAMME SCIATRAPHIS Donnell Smith.

Botanical Gazette

JULY, 1894.

Undescribed plants from Guatemala and other Central American Republics.[1] XIII.

JOHN DONNELL SMITH.

WITH PLATES XXIV—XXVI.

Heisteria Costaricensis Donnell Smith. (§ LEIOCARPÆ Engl.)—Folia disticha anguste lineari-lanceolata juxta basim acute angustata supra medium sensim in apicem mucrunculatum attenuata, margine adpresse retroflexo, petiolo brevi decurrente. Calyx urceolatus post anthesim retroflexus pedicelli dimidium æquans, dentibus brevibus triangularibus in setam desinentibus. Petala libera obovata ad apicem emarginata calyce sublongiora. Ovarium perianthium paullo superans latior quam longior collo coronatum. Calyx fructiferens coriaceus patulus pentagono-orbicularis cum pedicello breviore sanguineus subtus maculis albis notatus. Drupa ovata-globosa calycis radio brevior atro-cyanea.

A large bush with slender, drooping, and closely leafy branches that are toward their tips flexuose and angulate. Leaves 6–8^{in} × 9–11^{l}, membranaceous, pellucid-punctulate, glaucescent beneath. Petiole 3–4^{l} long, decurrent in narrow wings. Flowers scarcely a line high, apparently solitary. Stamens not seen. In fruit, pedicel $3\frac{1}{2}$–$4\frac{1}{2}^{l}$ long, calyx 10–12^{l} in diam. Drupe 5×4^{l}.—The only other species described, with similarly narrow leaves, *H. salicifolia* Engl. from South Brazil, is distinct by its calyx, which in fruit is cupuliform, deeply lobed, plicate and enclosing the pale drupe.—Forest on Rio Reventazón, Prov. Cartago, Costa Rica, alt. 2,000^{ft}, Mch. 1894, J. D. S., (ex Plantis Guatemalensibus necnon Salvadorensibus Hondurensibus Nicaraguensibus Costaricensibus, quas edidit John Donnell Smith, 4,760).

[1] The title of these papers, as well as that of the tickets accompanying the distribution of plants, has been changed to the form here employed, in order to include in the series some collections from other parts of Central America.

Cuphea Heydei Koehne (inserenda post *C. Liebmannii* Koehne in Engler's Bot. Jahrbüch. **2:** 409. 1882. Sect. x. MELVILLA Koehne, subsect. 5. Erythrocalyx Koehne). ICON: Koehne Atlas Lythracearum ined. *t. 44. fig. 380.*—Fruticulus *ramis junioribus dense hispidis* vetustioribus glabratis. Folia internodiis 2–3-plo longiora, basi acuta vel in petiolum 1–4^{mm} longum hispidum attenuata, elliptica v. lanceolata (24–54^{mm}: 11–17^{mm}), longe acuminata, parce ciliata, superiore pagina parce, inferiore in nervis densius hispida, vix rigidula, subtus pallidiora. *Flores solitarii; pedicelli axillares* 9–20^{mm} æquantes, parce hispidi, prophylla minutissima, quasi in setas 3–4 dissoluta summo apice gerentes. Calyx (22–26^{mm}) calcare orbiculari dilatato subincurvo (fere 3^{mm} longo latoque) instructus, subrectus, subgracilis, infra faucem ascendentem valde dilatatam plicatam subangustatus, verisimiliter intense coccineus, infra medium hispidus, intus glaberrimus; *lobi brevissimi, setis 4–6 ciliati; appendices lobis longiores, dorso seta valida munitæ. Petala* 0 *v. duo dorsalia minutissima subulata.* Stamina ad tubi $\frac{4}{5}$ lineæ rectæ inserta; episepala fere $\frac{1}{3}$ supra tubum exserta; epipetalorum 4 ventralia lobos aequantia, 2 dorsalia paullo breviora et ceteris vix inferius inserta; omnia glaberrima. Stylus glaberrimus, sub anthesi ovarium glaberrimum duplum aequans, demum circ. 8^{mm} exsertus. Discus crassus, ovato-cordatus, deflexus, supra sulcatus, subtus convexus. Ovula 9–14.—A *Cuphea Liebmannii* Koehne proxima differt calycibus majoribus appendicibus manifestis seta munitis et praecipue pedicellis axillaribus nec interpetiolaribus.

Nebáj, Depart. Quiché, Guatemala, alt. 7,000^{ft}, May 1891, Heyde & Lux, no. 4,480.

IPOMÆA FISTULOSA Mart., var. **Nicaraguensis** Donnell Smith.—Volubilis, foliis cordiformibus acuminatis discoloribus supra pubescentibus subtus cano-velutinis. Sepala pubescentia orbicularia. Corolla ad 3–4-pollicaris. Semina flavo-comosa.

Rio de Las Layas, Depart. Rivas, Nicaragua, alt. 120^{ft}, April 1893, Dr. W. C. Shannon, U. S. Army, no. 5,046.

Salvia Shannoni Donnell Smith. (§ CALOSPHACE.)—Suffrutex cano-pubescens. Folia ovato-lanceolata sensim acuminata ad basim acuta obtusave serrulata discoloria supra scabriuscula subtus cum petiolis velutina, floralia subconformia contractius acuminata flores superantia. Racemorum breviter pedunculatorum verticillastra coarctata 6–14-flora, infirma subremota. Calycis subsessilis tubuloso-campanulati labia late ovata, posticum integrum anticum acute dentatum. Corolla quam calyx duplo fere longior ad medium subæqualiter labiata, tubo gracili vix ventricoso sub exserto, labii inferioris lobo medio reniformi bifido. Stylus superne unilateraliter fimbriatus.

Leaves $3–4 \times 1\frac{1}{4}–1\frac{3}{4}^{in}$, petioles $6–8^{l}$ long. Racemes $3–5^{in}$ long; bracts sessile, herbaceous, pubescent, purplish, persistent, $8–10 \times 4–5^{l}$. Calyx pubescent, virescent or colored, 5^{l} long, lips $1\frac{1}{2}^{l}$ long. Corolla blue, 8^{l} long, nearly glabrous galea 3^{l} long; lip pubescent on back, 4^{l} long, middle lobe $1\frac{1}{2} \times 3^{l}$. Filament produced at articulation; anterior branch of connective $1\frac{1}{2}^{l}$ long, not dilated, glabrous, dentate. Inferior lobe of style $\frac{1}{2}^{l}$ long, the superior thrice longer.—Slopes of Volcan Chingo, Depart. Jutiapa, Guatemala, alt. $3{,}000^{ft}$, Oct. 1892, Dr. W. C. Shannon, U. S. Army, no. 3,612.

Triplaris Macombii Donnell Smith.—Folia pedalia oblique lateque elliptico-ovata abrupte acuminata ad basim late rotundata glabrata subtus rubro-punctulata, margine pilosiusculo, costa subtus adpresse pilosa. Racemi feminei (qui soli suppetunt) singuli aut bini aut terni ex summis axillis orti itidem in paniculam terminalem folia superantem congesti. Calycis fructiferentis lobi exteriores quam tubus oblongus altero tanto longiores linguiformes, sinuum late rotundatorum marginibus retroflexis, lobi interiores tubum subæquantes eique $\frac{2}{3}$-adnati setaceo-subulati ad basim plus minus appendiculati. Nuculæ nitidæ quam tubus $\frac{1}{3}$ brevioris facies ovatæ, stylis fauces haud attingentibus.

Branchlets smooth, sulcate, verrucose at nodes. Leaves membranaceous, undulate, inequilateral, $10–13 \times 6–7^{in}$; caudate acumination blunt, 5^{l} long; nervation immersed above, salient beneath, 17–19 lateral nerves straight and uniting in arches remote from margin, reticulation minute, longitudinal impressions nearly obsolete; petiole $8–11^{l}$ long. Panicle densely flavo-sericeous, rachis flexuose; racemes densely flowered from near base, $8–12^{in}$ long; bracts persistent, acuminate-ovate, margins continuing united below, within plurinerved and colored; pedicels as long (4^{l}), deflexed. Calyx of matured fruit 26^{l} long, pale-yellow; tube appressed-villose, 9×3^{l}; wings sparsely pilose, 17×5^{l}, obtuse, narrowed toward base; interior lobes somewhat unequal, about 3^{l} long.

Nutlet 5 × $3\frac{1}{2}^{l}$, styles 2^{l} long.—Most nearly related to *T. auriculata* Meisn. and *T. Arnottiana* Meisn., the originals of which in the Meisner herbarium of Columbia College have been compared.—Jiquilisco, Depart. Usulután, Salvador, alt. 220^{ft}, Jan. 1893, Dr. W. C. Shannon, U. S. A., no. 5,064. Named for Lieut. M. M. Macomb, U. S. Army, Engineer in Charge, Corps no. 1, Intercontinental Railway Commission.

Piper flavidum C. DC. in Donnell Smith Enum. Pl. Guat. **2**: 66; (§ III. STEFFENSIA C. DC.); foliis brevissime petiolatis lineari-lanceolatis basi æquali acutis apice acute acuminatis mucronulatisque utrinque glabris, nervo centrali circiter ad $\frac{1}{4}$ longitudinis nervos utrinque 3 alternos adscendentes mittente, petiolo glabro basi ima vaginante, pedunculo glabro petiolum superante, amento florente folii dimidium æquante, bracteæ vertice triangulari margine flavide hirsuto, bacca subtetragona apice subtiliter flavide hirtella.—Ramuli glabri internodiis brevibus, corticis collenchymate continuo zona fibrosa continua intus aucto, fasciculis intramedullaribus 2-seriatis. Limbi 8^{cm} longi 13^{mm} lati in sicco firmuli flavicantesque. Petioli ad 2^{mm} longi. Pedunculi 6^{mm} longi. Amentia florentia 3^{mm} crassa. Stamina 4.

Barranca de Rubelcruz, Depart. Alta Verapaz, Guatemala, alt. $2,500^{ft}$, Apr. 1889, J. D. S., no. 1,744.

Piper Tuerckheimii C. DC. in Donnell Smith Enum. Pl. Guat. **2**: 96; (§ III. STEFFENSIA C. DC.); foliis modice petiolatis, limbis 3^{cm} supra basin peltatis oblongo-ovatis basi rotundatis leviterque repandis apice acute acuminatis supra glabris subtus præsertim ad nervos hirtellis, nervo centrali circiter ad $\frac{1}{2}$ longitudinis nervos utrinque 3 oppositos adscendentes mittente, lateralibus 4–5 e basi solutis tenuibus, amento quam folium pluries breviore apice longe mucronato, pedunculo quam petiolus pluries breviore, bracteæ apice truncato-peltatæ pelta triangulari margine hirtella, bacca subglobosa vertice hirsuta.—Ramuli dense hirtelli. Limbi ad 24^{cm} longi ad 12^{cm} lati. Petioli 4.5^{cm} longi hirtelli basi vaginantes. Pedunculi 8^{mm} longi hirtelli. Amenti pars baccifera 5^{cm} longa mucro 2^{cm} longus hirtellus. Stamina 4.

Pansamalá forest, Depart. Alta Verapaz, Guatemala, alt. $3,800^{ft}$, Aug. 1886, von Türckheim, no. 1,038.

Piper Santa-rosanum C. DC. in Donnell Smith Enum. Pl. Guat. **2**: 96; (§ STEFFENSIA C. DC.); foliis modice petiolatis oblique rotundato-ovatis basi inæquali rotundatis subcordatisque apice obtusiuscule acuminatis utrinque dense velutinis 7-nerviis nervis 5 medianis validioribus, petiolo dense velutino basi ima vaginante, amento baccifero limbum æquante, pedunculo petiolum parum superante velutino, bractea spathulata apice rotundata utrinque et præsertim dorso hirsuta, ovario hirtello, bacca globoso-ovata hirtella.—Frutex 3–4^{m} altus. Ramuli dense velutini, cortex fasciculis collenchymateis discretis instructus fibris destitutus; fasciculi intramedullares uniseriati. Folia in sicco subrubescentia. Limbi in sicco firmi circiter 12^{cm} longi 7.5^{cm} lati. Petioli 1^{cm} longi. Amenta baccifera 3^{mm} crassa. Stamina 4, antheræ reniformi-globosæ caducæ filamentis circiter æquilongæ.

River-bank near Santa Rosa, Depart. Baja Verapaz, Guatemala, alt. 5,000^{ft}, Apr. 1887, von Türckheim, no. 1,174, distributed as *P. patulum* Bertol.; Santa Rosa, Depart. Santa Rosa, Guatemala, alt. 4,000^{ft}, May 1892 and Nov. 1892, Heyde & Lux, nos. 3,463 and 3,833; Capetillo, Depart. Zacatepequez, Guatemala, alt. 4,300^{ft}, Mch. 1892, J. D. S., no. 3,590.

Piper variabile C. DC. in Donnell Smith Enum. Pl. Guat. **2**: 66; (§ IV. CARPUNYA C. DC.); foliis modice petiolatis late ovatis basi truncato-rotundatis vel elliptico-ovatis basi subacutis omnibus apice acuminatis utrinque glabris, nervo centrali nervos ad $\frac{2}{3}$ longitudinis utrinque circiter 5 sursumque nervulos validos mittente, petiolo glabro basi ima vaginante, amento folium subæquante pedunculo quam petiolus paulo breviore, bracteæ vertice glabro triangulari superne breviter acutato unde subquadrangulari pedicelloque basi hirsuto, bacca obpyramidato-trigona glabra.—Ramuli glabri. Limbi in sicco subcoriacei opaci fuscescentes late elliptici 16.5^{cm} longi 12.5^{cm} lati, elliptico-ovati 16^{cm} longi 8.5^{cm} lati. Petioli 1.5^{cm} longi. Amenta baccifera ad 6^{mm} crassa. Stamina 3.—Species foliorum forma in ramis amentiferis ipsis valde variabili insignis.

Mountain-forests near Coban, Depart. Alta Verapaz, Guatemala, alt. 4,300^{ft}, May 1879, von Türckheim, no. 434.

Piper Donnell-Smithii C. DC. in Donnell Smith Enum. Pl. Guat. **2**: 95; (§ IV. CARPUNYA C. DC.); foliis breviter petiolatis lanceolatis basi æquali acutis apice longiuscule acute acuminatis utrinque glabris, nervo centrali circiter ad medium nervos utrinque 5 nervulosque validos mittente, petiolo basi ima vaginante, pedunculo petiolum æquante, amento quam folium pluries breviore, bracteæ apice turncato-peltatæ vertice triangulari margine hirtello pedicelloque lato hirtello, bacca parce hirtella.—Ramuli glabri tenues, cortex collenchymate proprio destitutus zona fibrosa continua instructus, fasciculi intramedullares sub-2-seriati. Limbi ad 13^{cm} longi ad 4^{cm} lati, in sicco membranacei nigrescentes opaci. Petioli 7^{mm} longi. Amenta submatura ad 4^{cm} longa 3^{mm} crassa. Stamina 3. Bacca obpyramidato-trigona in sicco nigra.—Species *P. eucalyptifolium* Rudge mire simulans amentis angustioribus ramulis haud uno latere hirtellis et verisimiliter staminum numero ab eo discrepans, a *P. concinno* C. DC. bracteæ pelta hirtella, a *P. Costaricense* C. DC. amentis brevioribus distincta.

Pansamalá, Guatemala, alt. $4{,}000^{ft}$, July, 1886, von Türckheim, no. 975.

Peperomia Cobana C. DC. in Donnell Smith Enum. Pl. Guat. **2**: 66; foliis alternis longiuscule petiolatis lanceolatis utrinque glabris, nervo centrali nervos utrinque 4–5–6 mittente, amentis apice caulis et ramuli axillaris aphylli 3 alternis foliorum limbos circiter æquantibus, ovario basi rhachi impresso apice oblique subulato antice stigmatifero.—Erecta glabra. Limbi ad 13^{cm} longi ad 5^{cm} lati in sicco subcoriacei opaci nervis ægre cernendis. Petioli ad 3^{cm} longi. Ramuli amentiferi pars infera sterilis 9^{cm} longa. Amenti pedunculus ad 2^{cm} longus. Amentum ipsum circiter 1^{mm} crassum. Bractea orbicularis.—Species *P. lancifoliæ* Hook. proxima petiolis multo longioribus ab ea præcipue discrepans.

Near Coban, Guatemala, alt. $4{,}600^{ft}$, June, 1879, von Türckheim, no. 78.

Peperomia Luxii C. DC.; foliis quaternis modice petiolatis e basi cuneato-obovatis apice emarginulatis utrinque glabris indistincte 3-nerviis in sicco coriaceis, amentis terminalibus pedunculatis pedunculos suos circiter duplo foliorumque limbos circiter triplo superantibus densifloris, rhachi glabra, bractea orbiculari coriacea centro pedicellata, ovario semiimmerso ovato in stylum gracilem apice stigmatiferum terminato, bacca ovata stylo ea breviore apice mucronata.—Herba procumbens glabra, caule in sicco coriaceo 4-sulcato vix 2^{mm} crasso. Limbi opaci circiter 15^{mm} longi 8^{mm} lati. Petioli circiter 3^{mm} longi. Pedunculi 2^{cm} longi. Amenta matura ad 5^{cm} longa 1^{mm} crassa.

Ojo de Agua, Depart. Santa Rosa, Guatemala, alt. 3,500^{ft}, Sept., 1892, Heyde & Lux, no. 3,828.

Phoebe amplifolia Mez et Donnell Smith; foliis amplissimis, adultis supra glabris nitidisque vel secus nervos adpresse tomentellis, dense nervis immersis areolatis, subtus tomento brevi puberulo, ad nervos ferrugineo mollibus, latissime ellipticis, apice breviter subacuminatis, penninervibus; inflorescentia dense ferrugineo-tomentella, submultiflora, laxiuscule panniculata, foliis multo breviore; floribus dense ferrugineo-tomentellis; limbi segmentis æqualibus, subobtusis; filamentis pilosis quam antheræ multo brevioribus; antheris omnibus 4-locellatis; ovario glaberrimo.—Arbuscula videtur (ex ramorum habitu), ramulis crassis, dense adpresseque ferrugineo-tomentellis basin versus cinerascentibus, striatim subangulatis; gemmis dense ferrugineo-tomentosis; cortice esipido, paullo mucoso. Folia petiolis usque ad 32^{mm} longis, validissimis, supra profunde canaliculatis, tomento peradpresso brevissimoque adultioribus cinereo obtectis stipitata, sparsa, rigide coriacea, supra (præter nervos adpresse cinereo-tomentellos) adulta saltem glabra nitidaque et dense venulis immersis areolata, subtus tomento brevi puberulo, ad nervos ferrugineo mollia valde prominenti-reticulata, latissime elliptica, basi breviter acuta apice breviter lateque subacuminata, ex specimine nostro usque ad 0.3^{m} longa, 0.16^{m} lata, costis e nervio medio sub angulo 45–60° prodeuntibus, margine quam maxime recurvato, in statu sicco præsertim basin versus solemniter lateque replicato. Inflorescentia laxiuscule panniculata late subthyrsoidea, dense adpresseque tomento ferrugineo obtecta, foliis permulto brevior; pedicellis sæpius 4^{mm} vel paullo infra longis, bracteolis deciduis. Flores dense adpresseque ferrugineo-tomentelli, limbi segmentis quam genitalia multo longioribus, æqualibus, lingulatis, apice subobtusis. Filamenta pilosa quam antheræ multo breviora, ser. III basi glandulis binis magnis, sessilibus aucta. Antheræ subquadraticæ, obtusæ, omnes quatrilocellatæ, locellis ser. II exteriorum introrsum, ser. III sublateraliter dehiscentibus. Staminodia perconspicua filamento manifesto, piloso stipitata. Ovarium glaberrimum, subglobosum; stylo crasso subæquilongo; stigmate pulvinato. Bacca maxima (± 33^{mm} longa, 22^{mm} diametiens), bene ellipsoidea, cupulæ crassæ, subpateriformi, obscure duplicimarginatæ, sensim conice in pedicellum valde incrassatum transeunti insidens.

El Jute, Depart. Quiché, Guatemala, alt. 10,000^{ft}, Apr. 1892, Heyde et Lux, no. 3,033.

EXPLANATION OF PLATE XXIV.—Fig. 1, flowering and fruiting branch.—Fig. 2, posterior view of stamen ser. 1.—Fig. 3, anterior view of stamen ser. 3, with glands —Fig. 4, posterior view of stamen ser. 4.—Fig. 5, Pistil. (Fig. 1 is natural size; the others are variously enlarged.)

Nectandra Heydeana Mez et Donnell Smith; foliis adultis præter costarum axillas subtus sæpius perconspicue barbellatas glabris, optime ellipticis, basi nunc rotundatis nunc breviter acutis, apice sueto acumine brevi sed eleganti præditis, utrinque valde prominulo-reticulatis; inflorescentia subcorymbosa vel subpyramidata, glaberrima; floribus hermaphroditis, glabris, $\pm$ 7^{mm} diam. metientibus; filamentis ser. I, II nullis; ovario glabro, stylo subæquilongo.—Arbuscula 12–24^{ped} alta (ex cll. Heyde et Lux!), ramulis glaberrimis, atris vel cinerascentibus, apicem versus lineatim angulosis, gemmis dense sulfureo-strigulosis nonnunquam minute sericantibus, cortice esipido. Folia petiolis usque ad 20^{mm} longis (sed sæpius conspicue brevioribus quoque), supra leviter canaliculatis, sub lente primum peradpresse sulfureo-strigulosis demum glabratis stipitata, sparsa, tenuiter membranacea vel membranacea, præter costarum axillas subtus sæpius perconspicue barbellatas glaberrima, utrinque valde prominenti-reticulata supra (sicca) olivacea nitida, subtus minute rubenti-viridia subnitida, optime elliptica, basi sueto rotundata rarius breviter acuta, apice sæpius acumine brevi sed eleganti prædita, $\pm$ 0.16^{m} longa, 72^{mm} lata, costis e nervio medio sub angulo 50–60° prodeuntibus, margine haud recurvulo, sæpius eleganter undulato. Inflorescentia subpauciflora, subcorymbose vel subpyramidatim panniculata, glaberrima, foliis brevior; pedicellis longis (sæpius 7^{mm} metientibus); bracteolis deciduis. Flores hermaphroditi, glabri, $\pm$ 7^{mm} diam. metientes, limbi segmentis patentibus, æqualibus, ellipticis, apice rotundatis. Filamenta ser. I, II desunt; ser. III glabra sed generis ritu papillosa, antheris duplo vel ultra breviora, percrassa, basi glandulis binis minutis, globosis, sessilibus aucta. Antheræ ser. exteriorum suborbiculares, apice bene rotundatæ, papillosæ. Ovarium glabrum, subglobosum, stylo crasso, subæquilongo. Fructus ignotus.

Santa Rosa, Depart. Santa Rosa, Guatemala, alt. 3,000^{ft}, Nov. 1892 and Jan. 1893, Heyde et Lux, nos. 4,260 and 4,578.—PLATE XXV.

Pedilanthus macradenius Donnell Smith. (§EUPEDILANTHUS Boiss.)—Folia glabra ampla obovato-oblonga angulo obtusissimo terminantia, basi obtusa. Cymæ ex axillis supremis ortæ breves oligocephalæ, bracteis oblongo-ovatis pedunculos superantibus. Involucrum ad basim rectangulare, calcaris quam tubus paullo minoris deflexi glandulas 2 majusculas gerentis labiis ovatis sub apice plica intrusa auctis, tubi lobis binis inferioribus ovatis cano-fimbriatulis superiore cum intermediis aequilongis alte connato. Bracteolæ numerosissimæ flores masculos aequantes, pedicellis masculis et femineo filamentisque glabris. Capsula depresso-sphaerica lineis dehiscentiæ 6 latis albis notata.

Arboreous. Leaves olive-green, at apex of branchlets 4–6 × 2–3^{in}; petioles smooth, 3^{l} long. Bracts rubescent beneath hoary pubescence, 6 × 3^{l}. Peduncles pubescent. Involucre rubescent, smooth within, 5–6^{l} long, spur 3½ × 2^{l} with oval glands 1^{l} long, tube 4 × 3^{l}. Capsule 4^{l} in diam., coccules ecarinate, seeds trigonal-globose.— Canival, Depart. Huehuetenango, Guatemala, alt. 3,200^{ft}, Dec. 1891, Dr. W. C. Shannon, U. S. Army, no. 412.

Æchmea Friedrichsthalii Mez et Donnell Smith; foliis super vaginam longe paullo angustatis, spinulis minutis armatis vel interioribus saepius fere omnino inermibus; inflorescentia bipinnatim vel imperfecte tripinnatim panniculata, e ramulis distiche florigeris subpatentibus composita, densiuscula subellipsoidea; bracteolis florigeris reflexo-patentibus, latissime ovatis breviterque (nec pungenter) acuminulatis, ovarii medium haud attingentibus; floribus ad 17^{mm} longis, sessilibus; sepalis liberis vel minutissime tantum connatis, apice in aciculum minutissimum (fructiferis saepius deciduum) dorsalem productis; petalis in spinulam terminalem desinentibus, altiuscule ligulatis; filamentis ser. II cum petalis peralte connatis; placentis interno loculorum angulo apici affixis.—Epiphyta (ex cl. Friedrichsthal !), acaulis, florifera ad 0.5^{m} alta. Folia e vagina ovali, margine nunc integerrima nunc dissite spinulis parvis, patentibus aucta, praesertim dorso adpresse allutaceo-lepidota in laminam ensiformem producta, saepius 0.6^{m} vel paullo ultra longa, submembranacea vel tenuiter chartacea, apice longius breviusve acuta, spinulis haud ultra 1^{mm} longis praedita vel interiora fere subinermia, interiora saltem apicem versus pulchre rubentia, subglabra. Inflorescentia multiflora, apicem usque e ramulis distiche florigeris, subpatentibus, vix ultra 55^{mm} longis composita, foliis brevior, in scapi gracilis, glabri vel perparce lepidoti, vaginis pulchre rubentibus membranaceis, suberectis, lanceolatis perlongeque acutis, inferioribus margine minutissime spinulosis superioribus integerrimis, paullo lepidotis, internodia superantibus praediti apice elata, ovoidea vel ellipsoidea, $\pm 0.15^{m}$ longa, 90^{mm} diam. metiens, glaberrima; ramulis conspicue undulatis, 6–10-floris; bracteis primariis infimis anguste lanceolatis, peracutis, ramulos axillares ultra dimidium aequantibus, reflexis; bracteolis florigeris 3.5–5^{mm} longis, reflexo-patentibus, submembranaceis, tenuissime solum saepiusque obscure venoso-lineatis, glabris, latissime ovatis breviterque (nec pungenter) acuminulatis, satis concavis. Flores per anthesin secus ramulos stricte erecti, sessiles, 17^{mm} longi, glabri; sepalis liberis vel basi minutissime solum connatis, 5.5^{mm} longis, apice in aciculum minutissimum, brunneum, dorsalem productis, latere tecto in alam maximam aciculo multo altiorem dilatatis. Petala 13^{mm} longa, ex ungue lineari in laminam angustam, sublanceolatam, peracute in spinulam terminalem transeuntem dilatata, 2^{mm} a basi ligulis binis profunde fimbriato-incisis aucta. Stamina petalis paullo breviora, filamentis anguste linearibus, tenuibus, ser. I liberis, ser. II cum petalis peralte (ultra laminæ basin) intime connatis; antheris luteis, fere 3^{mm} longis, lanceolatis, utrinque sed praesertim apice acutis, prope medium dorsifixis. Ovarium subglobosum, longitudinaliter sulcatum, ad 7^{mm} longum; tubo epigyno subnullo; stylo antheras exacte aequante, gracili; stigmatibus longe divisis, perangustis, laxe spiraliter contortis. Bacca cœrulea !, globosa, *Pisi* magnitudine, sepalis persistentibus tenuiter conice conniventibus coronata; seminibus allutaceis, vix 2^{mm} longis.

Isla de Catina, Rio San Juan, Nicaragua,[1] 1839, Friedrichsthal, no. 609, (herb. Vindob.). Rio Jiménez, Llanos de Santa Clara, Comarca de Limón, Costa Rica, alt. 650^{ft}, Apr. 1894, J. D. S., no. 4,962.

Pitcairnia puberula Mez et Donnell Smith; foliis exterioribus ignotis, interioribus haud petiolatis, anguste lanceolatis, integerrimis, subtus junioribus lepidibus albis pilos magnos simulantibus furfuraceis; inflorescentia simplicissima,

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[1]Mr. Hemsley has remarked, that all of Friedrichsthal's plants in the Kew herbarium are ticketed as from Guatemala; and this is the case also with the Vienna specimen above cited. In fact, the collections were made in Nicaragua and Costa Rica.

medium usque laxiuscule, apicem versus dense racemosa, multiflora; foliolis scapalibus internodia longe superantibus; bracteis maximis, triangulo-lanceolatis, infimis flores axillares triplo vel ultra superantibus; floribus pedicellis brevibus crassisque stipitatis; sepalis anguste triangularibus, haud carinatis; petalis eligulatis; seminibus utroque polo tenuiter caudatis.—Imperfecte solum cognita, florifera vix ultra 0.4^{m} alta. Folia rosulæ desunt. Scapus validus, erectus, foliis permanifeste brevior, lepidibus araneosis cinereis vel albidis puberulus, dense foliolis iis rosulæ absque dubio æqualibus, anguste lanceolatis, longe peracutis, viridibus, supra glabris subtus junioribus lepidibus albidis pilos magnos simulantibus dense furfuraceis, adultis $\pm$ perfecte glabratis, omnibus erectis internodiaque perlonge superantibus, inflorescentiamque medio fere æquantibus usque ad 18^{mm} latis, omnino inermibus instructus. Inflorescentia simplicissima, medium usque laxiuscule apicem versus dense racemosa, paullo infra 0.2^{m} longa, 40^{mm} diam. metiens, cylindrica apiceque rotundata, multiflora; rhachi recta, haud vel vix angulata, lepidoto-puberula; bracteis inflorescentiæ basin versus persensim in folia scapalia transeuntibus triangulo-lanceolatis longissimeque acutis, erectis, infimis flores axillares triplo vel ultra superantibus, supremis quam sepala subduplo brevioribus. Flores deflorati fructiferi solum cogniti stricte erecti, pedicellis percrassis, lepidoto-puberulis, haud ultra 4^{mm} longis stipitati; sepalis subglabris, ad 21^{mm} longis, e basi 5^{mm} lata in apicem acutam sensim angustatis triangularibus, symmetricis, haud carinatis. Petala (nonne revera, ut ex sicco videtur alba vel lutea?) eligulata. Genitalia ignota. Capsula matura $\pm$ 18^{mm} longa, ad $\frac{5}{8}$ longit. supera, tenuiter conice perlongeque acuta, basin usque dehiscens, seminibus 2.5^{mm} longis, fere rectis, utrinque cauda tenui egregiaque appendiculatis.—OBS. Species persingularis, Eupitcairnieis adscribenda sed pedicellis crassis bracteisque infimis saltem perelongatis quam maxime notabilis. Binæ adhuc solum hujus gregis species e Guatemala allatæ mihi cognitæ, quæ petalis eligulatis gaudent, utraque infeliciter imperfecta solum mihi ante oculos. (MEZ.)

Cenaguilla, Depart. Santa Rosa, Guatemala, alt. $4,000^{ft}$, Sept. 1892, Heyde & Lux, no. 3,879.

Anthericum apodastanthum Donnell Smith. (Subgenus HESPERANTHES Baker.)—Folia radicalia linearia graminoidea valde 15–17-nervata, margine vix ciliolato. Scapus sesquipedalis teres glaber ebracteatus. Racemus (in exemplaribus mihi suppetentibus) simplex flexuosus, nodis inferioribus remotissimis. Bracteæ interiores ovatæ cuspidatæ, exteriores lanceolatæ denique subulato-attenuatæ. Pedicelli terni in medio articulati. Perianthii segmenta perspicue 3-nervata, interiora in sicco lutea. Filamenta muriculata nunc ovarium aut antheras aequantia nunc eis duplo longiora. Stylus nunc ovarii nunc perianthii longitudinem aequiparans. Capsula oblongo-ovalis perianthio marcido ½ brevior semina in loculo quoque 9–10 habens.

Rhizome not seen. Leaves $12–15^{in} \times 2–3^{l}$. Raceme $7–8^{in}$ long, lower internodes $1\frac{1}{2}–3^{in}$ long, exterior bracts at length 1^{in} long, pedicels $4–9^{l}$ long. Perianth $6–7^{l}$ long. Anthers $1\frac{1}{2}^{l}$ long.—Indicated by Mr. J. G. Baker as undescribed and nearest to his *A. Skinneri*.—San Bartolo, Depart. Zacatepequez, Guatemala, alt. $5,000^{ft}$, May, 1890, Heyde & Lux, no. 4,644.

Gymnogramme sciatraphis Donnell Smith.—Stipites e caudice brevi crasso caespitosi graciles spithamæi straminei glabri, basi paleacea. Frondes acuminato-ovatæ pedales glabræ 4–5-pinnatim decompositæ, jugis plurimis confertis, pinnis pinnulisque oppositis e basi truncata subsessili ovatis lanceolatisve, pinnis infimis maximis, pinnulis ser. II rhomboideis 1–2-fidis, ultimis ellipticis deorsum attenuatis plerumque bifurcatis, segmentorum nervio unico infra medium usque ad furcam sorifero.

Scales ovate, $3–4^{l}$ long, rigid, blackish, imbricating. Stipes and rachises canaliculate. Sterile and fertile fronds similar, 20–26-jugate. Basal pinnæ accuminate-deltoid, spreading, incurved, $6–7\frac{1}{2}^{in}$ long, 15–20-jugate; its lower pinnules 2^{in} long, 9–12-jugate. Segments oblong, acute, $1–1\frac{1}{2}^{l}$ long, fruit-dots cylindrical.—To be grouped with *G. chaerophylla* Desv. and *G. schizophylla* Baker, which differ chiefly by absence of caudex and of scales, circumscription and loose pinnation of fronds.—Shaded precipitous banks of Rio Jiménez, Llanos de Santa Clara, Comarca de Limón, Costa Rica, alt. 650^{ft}, Apr. 1894, J. D. S., no. 5,084.

Baltimore, Md.

Explanation of Plate XXVI.—Fig. 1, frond.—Fig. 2, pinnule.—Fig. 3, pinnule of second order.—Fig. 4, ultimate pinnule.—Fig. 5, scale from base of stipe. (Figure 1 is somewhat reduced; the others are variously enlarged.)

A preliminary synopsis of the North American species of Amaranthus.

EDWIN B. ULINE AND WILLIAM L. BRAY.

In selecting work for the present year, our attention was called to the comparatively untried field of North American Amaranthaceæ. The only systematic work since Moquin-Tandon's exhaustive revision of the order was that of Dr. Asa Gray in Proc. Amer. Acad. **5**: 168–9, where he presented a short synopsis of our western Amblogynes, restoring the old generic name of *Amblogyne* Raf., which had been reduced to a section of Amaranthus by Bentham in Fl. Australiensis **5**: 212. Aside from this and an occasional new species by Watson, Torrey and others, we were left to the difficult task of disentangling the vague and conflicting statements of Linnæus and Willdenow, and of setting them right as far as possible with Moquin-Tandon and subsequent writers. Up to the present time our study has been confined to the genus Amaranthus.

Geographically, an attempt has been made to embrace forms from Mexico and the West Indies whenever material and facts were at hand, though they may only meagerly represent the forms that will yet be found in those regions.

For the use of herbarium material, grateful acknowledgments are due to Dr. John M. Coulter, Dr. Wm. Trelease, Dr. N. L. Britton, Mr. F. V. Coville, Dr. B. L. Robinson, Prof. John Macoun, Dr. C. E. Bessey, Mr. John Donnell-Smith, Mr. Walter Deane and Mr. Jared G. Smith. Over 1,000 herbarium sheets of the genus Amaranthus alone were placed at our disposal, substantially comprising the existing material in the larger herbaria of the United States and Canada. With the Missouri Botanical Garden collection came the Bernhardi collection, which has been of inestimable value to us in revealing the European conception of some of the older species. Mr. Hitchcock's West Indian collection and Mr. John Donnell Smith's Central American plants have been especially interesting in pointing out the probable line of travel that many of our introduced species have taken from their original tropical home. The late Dr. Thomas Morong's collection in the Columbia College Herbarium fairly represents the South American forms.

The characters that are used in the following synopsis to circumscribe sub-groups are by no means absolute, for there is always some shading off and overlapping in one particular or another, which is forever bound to resist every attempt at definite separation. Yet they are natural groups worked out from a common origin, and the group characters herein set forth can only serve to point out these broader lines of differentiation along the path of descent. Likewise many of the species approach dangerously near to one another; and the complex question of adaptation and modification of adventive forms together with the still greater uncertainty which prevails in regard to hybridization among certain groups of species has rendered the question of specific limitation one of peculiar difficulty and uncertainty. This problem still remains unsolved; and only to him who is willing to bestow years of study on the group as it may be seen in nature and under cultivation will there come any great reward. In the meantime much of the vagueness that has heretofore existed must continue to encumber us.

The species may be presented in the following order:—

§ 1. *Sepals 5, abruptly contracted into a narrow claw, more or less united at base, or free.* (AMBLOGYNE.)

This section is as well marked in geographical limits as in flower characters, being restricted with few exceptions to Texas, New Mexico, Arizona, Nevada, southern California and the arid plains of northern Mexico. The characteristic rank weedy nature of the genus is somewhat overcome here by a tendency to color and gracefulness of habit.

* *Plants monœcious.*

+ *Stamens 2 or 3.*

++ *Utricle indehiscent.*

1. A. BERLANDIERI (Moq.).

Sarratia Berlandieri Moq. DC. Prod. **132:** 268. 1849.

Stem slender, ascending or erect, 15 to 30^{cm} high, branching from base: leaves crowded, deciduous on the older parts of the stem, oblong-obtuse to oblanceolate, 1.5 to 2.5^{cm} long: inflorescence in small clusters, crowded, axillary: flowers darkish, short (2^{mm}): bracts one-third as long as the sepals: stamens two: fruiting sepals 3-nerved, coalescent for one-third their length, not constricted into a tube above: utricle indehiscent.—Texas, from Austin and Big Springs to the Rio Grande, and northeastern Mexico.

These forms have been known as *A. polygonoides*, but the more leafy smaller habit, more minute glomerules, smaller darker flowers, more spreading membranaceous sepals and uniformly dehiscent utricle clearly justify their separation as a distinct species. Its affinities are much stronger in the direction of *A. urceolatus*, from which it is easily distinguished by the marked difference in sepal venation. Critical comparison of number 2279 of Berlandier, Moquin's type number, with Berlandier 981, 2411 and 859 can leave no possible doubt of their identity with *Sarratia Berlandieri* Moq.

2. A. URCEOLATUS Benth. Bot. Voy. Sulph. 158. 1844.

Amblogyne urceolata Gr. Proc. Am. Acad. **5**: 168. 1861.

Slightly branched: leaves rather small and narrow: sepals of female flower unequal in width, the two exterior with slightly narrowed tri-carinate claw; lacineæ with spatulate or orbicular laminæ, the three interior with strongly narrowed uni-carinate claw, all with entire or slightly crenulate margin with green branching nerves: utricle indehiscent.—The species not reported from North America, but represented by three varieties.

No. 154 Palmer in part from Guaymas, Lower California, is a variety with more branching habit and long lanceolate leaves on very long slender petioles. The more vigorous vegetative character is probably due to growing in gardens.

✓Var. OBCORDATUS (Gray).

Amblogyne urceolata var. *obcordata* Gr. Proc. Am. Acad. **5**: 169. 1861.

Lamina or dilated summit of sepals strongly notched and nearly obcordate.—Western Texas and New Mexico.

✓Var. **Jonesii,** n. var.

Plant dwarfed, branching at base, erect, spreading, 7 to 15^{cm} high: stem slender, smooth, purple: leaves scattered, oblanceolate to linear, 1.5 to 2^{cm} long: flowers bright purple: staminate sepals 5: stamens 3: sepals of pistillate flowers abruptly narrowed below, white-margined, with one slightly branched bright purple mid-vein: utricle purple, narrowly oblong, thin indehiscent.—Collected at Bowie, Arizona, in 1884 by Marcus E. Jones.

++ ++ *Utricle dehiscent by a circumscissile line.*

3. A. POLYGONOIDES L. Pl. Jam. Pugill. **2**: 27. 1759.

Amblogyne polygonoides Raf. Fl. Tellur. 42. 1836.
Amarantus polygonoides Hemsley Biol. Cent. Amer. **3**: 14. 1882, in part.

Restricted in range to Florida and West Indies. Stockier and fleshier than its western relative, *A. Berlandieri.* These two forms are probably descendants of a common early tropical species and owe their divergence in part to the difference in route along which they have traveled; one reaching Florida by way of the West Indies, the other coming across the plains of Mexico as far as Texas and New Mexico.

4. A. FIMBRIATUS Benth. Wats. Bot. Calif. **2:** 42. 1880.

Easily known by the broad fimbriate often beautifully colored sepals.—Reported abundantly from southern and eastern California, Nevada and southern Utah, western Texas, Arizona, New Mexico, southward into Mexico and Lower California.

✓Var. DENTICULATUS (Torr.).

A. venulosus Wats. Proc. Amer. Acad. **17:** 376. 1882.
Sarratia Berlandieri var. *denticulata* Torr. Bot. Mex. Bound. 179. 1858.

This is not diœcious as Watson described it, but agrees with *A. fimbriatus* except that the broadly dilated lamina of the sepals is not fimbriate, but entire or emarginate, and conspicuously marked by branching green veins.

5. A. PRINGLEI Wats. Proc. Amer. Acad. **21:** 476. 1886.

Known from *A. fimbriatus* by the more scattered axillary inflorescence, distinct sepals with green mid-rib, broad scarious margin not fimbriate, longer acute outer sepal and longer spiny bracts.

Probably has much the same range as *A. fimbriatus*, but is not reported from so many stations, nor in so great abundance.

6. A. SQUARRULOSUS (Gray).

Ambloygne squarrulosa Gr. Proc. Am. Acad. **5:** 168. 1861.
Scleropus squarrulosus. Anderss. ined.

A species from the Galapagos Islands, with the broadly ovate or rhombic-ovate lamina of the female sepals all abruptly contracted into a narrow claw, peduncles and pedicels thickened, as in *A. crassipes*. Plant tall and slender, resembling *A. fimbriatus*.

This would at first seem to fall in the Scleropus section by reason of its thickened peduncles and the shape of its sepals; but the incrassate tendency is by no means so strongly marked as in that group, while the tall, slender habit and the abrupt narrowing of the sepals into a slender claw serve easily to distinguish it.

+ + *Stamens five.*

The two following species show a departure from the typical Amblogyne character toward the Euamaranthus group, in flower characters particularly.

7. A. CHIHUAHUENSIS Wats. Proc. Amer. Acad. **21**: 436. 1886.

Leaves ovate-lanceolate to oblong: sepals broadly spatulate, setose-apiculate with green (sometimes branching) mid-vein much thickened at base. Apparently not found in any of the border states.

Collected by Palmer at Hacienda San Miguel, Chihuahua (no. 197), in 1887.

8. **A. Bigelovii,** n. sp.

Monœcious, erect, 4 to 5^{dm} high with abundant slender erect rather short branches: leaves lanceolate, obtuse, 4 to 7^{cm} long, with long slender petiole, much reduced toward the apex of the branches, becoming oblong-elliptical, all prominently mucro-tipped, with prominent veins: inflorescence leafy, axillary, crowded toward the extremity of branch, the stem terminated by a leafy spike: bracts subulate, pungent, slightly exceeding the calyx, 3^{mm} long: staminate flowers with five stamens and five sepals: pistillate flowers with sepals spreading, rather unequal, spatulate-obtuse, the two lateral acute, the one next the bract mucronate-tipped: utricle circumscissile with calyptra very much folded and retracted after dehiscence.—Collected in the Mountains of the Cibola in 1852 by Dr. Bigelow (no. 1,190). Distributed as *Sarratia Berlandieri* Moq.

Var. EMARGINATUS (Torr.).

Sarratia Berlandieri var. *emarginata* Torr. Bot. Mex. Bound. 179. 1859.

Laciniæ of the female calyx widely wedge-shaped, emarginate.—Collected at Camp Green, New Mexico, by Dr. Parry.

* **Plants dioecious.*

+ *Utricle indehiscent: sepals equal.*

9. A. GREGGII Wats. Proc. Amer. Acad. **12**: 274. 1877.

Differs strikingly from both *A. Torreyi* and *A. Palmeri* in habit and in the very short bracts, while the utricle character not only of this but particularly of the following variety is remarkably suggestive of that of *A. pumilus*.—Collected by Dr. Gregg near the mouth of the Rio Grande in 1848.

The fact that but one locality has ever been reported, and that only the pistillate flowers and the upper part of the plant are in existence, places this species on a rather perilous footing.

Var. **Muelleri,** n. var.

Plant more branching: leaves longer, narrower: inflorescence freely branching: sepals spreading, 2^{mm} long, two-thirds as long as the broadly ovate inflated coriaceous utricle: seed larger.—Collected by Mr. Fred Mueller near Vera Cruz in 1853.

It is only for convenience in presentation that these two inseparable forms are permitted to fall with the other diœcious species, with which their affinities are otherwise very slight. In the utricle characters they display affinities for the Euxolus group, while in habit they are quite anomalous. More material and added knowledge may lead to a very different disposal of them.

10. A. TORREYI Benth. Wats. Bot. Calif. **2**: 42. 1880.

Western plains from Nebraska to Mexico, extending as far west as Nevada. It is the only northern diœcious form, being replaced in the south-west by the more abundant *A. Palmeri.*

Var. **suffruticosus,** n. var.

Stem woody: leaves narrowly rhombic-ovate, with numerous prominent nerves on the under surface. Distributed as *Amblogyne Torreyi.*—Lower California, Cape St. Lucas (*Xantus* 100 of 1859–60).

11. A. PALMERI Wats. Proc. Amer. Acad. **12**: 274. 1877.

Distinguished by its long terminal spikes and very long rigid pungent bracts.—It is found from western Texas, through central New Mexico and Arizona to the Pacific Coast, but reaches its greatest display in the plateaus of northern Mexico, where it is one of the commonest of plants in gardens, cultivated fields and bottom lands. Very variable.

Var. **glomeratus,** n. var.

Low, decumbent or ascending, branching at base: leaves narrow, very small (not exceeding 1.5^{cm}): fertile flowers aggregated below in large dense glomerules becoming 3 to 5^{cm} in diameter at the base of the plant: sepals more spreading. —Collected in 1889 by Dr. Palmer at Lerdo, Sonora, Mexico (953 ♀, 958 ♂).

A form from Lower California (*Orcutt,* 1884) is taller and stouter and has not the display of pistillate glomerules at base; but in general aspect it presents greater affinities here than for the species.

(*To be concluded.*)

Herbarium Lake Forest University, Lake Forest, Ill.

Notes on our Hepaticæ. II.

The genus Riccia.[1]

LUCIEN M. UNDERWOOD.

The main purpose of these notes, made in reviewing the material that has been accumulating in my herbarium for the last few years, is to call the attention of local collectors to these much neglected and inconspicuous plants in order to learn more definitely their distribution. We still know almost nothing of the distribution of most of the American species, certain forms being known only from widely separated stations with no information from the intermediate territory. There is a strong probability that many species will yet be found especially in lowlands of the southern Atlantic states, in the Gulf states, and on the Pacific coast where the climatic conditions more nearly approach the Mediterranean region of the old world, where the genus is well developed.

The genus as now limited excludes the various forms of *R. fluitans* and *R. natans* which will form genera by themselves.

RICCIA FROSTII Aust. is probably widely distributed from the Rocky mountain region eastward to Illinois and Ohio. The specimens distributed as *Riccia crystallina* in Hepaticæ Americanæ, no. 63, are of this species. *R. Watsoni* Aust. founded on male plants is doubtless the same species, as originally suggested by its author. The only specimens purporting to be of this species that I have seen are in Herb. James from Wolf and Rothrock's collections on the Wheeler Survey; these are fertile and conform to the type of *R. Frostii*. Specimens from the eastern portion of the range are more robust than the mountain forms but the spore characters are similar; they may be characterized as follows:

RICCIA FROSTII **major,** n. var.—Thallus much larger than in the type, 3–4 times dichotomously branched, irregularly spreading and somewhat imbricate, the divisions wider, commonly tinted with purple at the margins.—Banks of Missouri River, St. Charles, Mo. (*Demetrio*, no. 5); Manhattan, Kansas (*Kellerman*); sterile forms are also at hand from Illinois (*Wolf*).

[1] No. I of this series is in this journal **14:** 191–198. 1888.

R. ALBIDA Sulliv. is known only by two plants. The type was collected by Wright in Texas in 1845 and is in the Sullivant collection. I have received a single plant from Langlois, collected in Louisiana. Both plants are lacking in fruit. The plant is allied to *R. glauca* in its vegetative characters but its spores are a desideratum in order to understand its affinities.

R. LAMELLOSA Raddi as represented in Austin's Hepaticæ Bor.-Am. no. 140 has spores quite unlike those figured in Lindenberg (Monog. Ricc. *t.30*), lacking the hyaline margin. It may prove to be an undescribed species, but until Raddi's type, if in existence, can be seen it will be desirable to let it rest in its present position. The spores in this specimen are very characteristic, being 84–94μ in diameter, clearly and regularly but not strongly reticulated over the rounded surface. Austin's plants were from Closter, N. J.; the same plant has been sent from Mobile, Ala., by Dr. Mohr.

R. ARVENSIS, var. HIRTA Aust. is apparently a very distinct species differing widely from *R. arvensis* in the densely ciliate margins of the thallus and especially in the larger spores (92–108μ) which are nearly black and consequently almost opaque and very indistinctly reticulate. It was issued by Austin (Hep. Bor.-Am. no. 142) but the specimens in the set in my herbarium are sterile; Austin has described the spores in his MSS. now in my possession, which is important since they were omitted in the original description. Specimens sent me in 1884 by Parish from San Bernardino, other material collected by Bolander, and especially the fine material furnished by Dr. Campbell for our exsiccatæ (Hepat. Amer. no. 138) have enabled me to separate and distinguish this very distinct and elegant species, which will take the name **Riccia hirta** Aust. (1869, as synonym.)

R. CALIFORNICA Aust. was very imperfectly described and the type is inaccessible if in existence. I have referred to this species some sterile fragments from the California Academy of Science, and fragmentary fertile specimens collected near Berkeley by M. A. Howe, which closely agree with the brief description. The light brown spores with faint reticulations with very small areolæ (12–14 measuring the convex surface of the spore) are quite characteristic of these specimens. More material is needed to trace the full character of the species and the same is true of its congeners *R. tumida*

Lindenb. (known only from the very imperfect specimens distributed in Austin's Hepat. Bor.-Am.) and *R. ciliata* which is known from this country only through the report of Austin, there being, so far as I know, no specimens at hand.

R. CRYSTALLINA L.—The figures of this species in Lindenberg's Monograph do not fairly represent the species as it appears in various European exsiccatæ nor do they conform to the usual description. Misled by this inaccurate representation we issued plants under this name that are quite readily distinguished from *R. crystallina* now that suitable material is at hand for comparison. There is some resemblance between *R. crystallina* and *R. Frostii* in the method of dissemination of spores but they are distinguished by their thallus characters.

The following undescribed species have been sent in from southern and lower California:

Riccia aggregata, n. sp.—Thallus 1–3 dichotomous, forming more or less radiately divided crowded masses 1–2^{cm} or more in diameter; divisions of the thallus narrow (1–1.5^{mm}), solid, papillose-reticulate and green above, purplish beneath and provided with purplish scales not exceeding the margin of the thallus which is somewhat membranous; capsules rather prominent, with a purple spot in the thallus just above; spores 70–78μ in diameter, nearly black, finely reticulate but almost opaque, scarcely margined.

On the ground, Pasadena, California, March 1893. (*A. J. McClatchie*, no. 24.)

Riccia Catalinæ, n. sp.—Thallus thin, loosely attached to the soil, 3–4^{cm} in diameter, stellately or radiately 3–6 dichotomous; divisions of the thallus broad (2–3^{mm}), more or less reticulate-spongy above, the apices more or less expanded and emarginate, naked beneath and at the margins; capsules large, in one or two rows; spores 86–95μ in diameter, very dark brown, nearly opaque, with very large obscure reticulations which often contain a free ridge-like crest, bordered with a more or less minutely crested margin.

Wet soil in a cañon, Santa Catalina Island, California, September, 1893. (*McClatchie*, no. 441.)

Riccia Brandegei, n. sp.—Thallus orbicular, 2–4^{cm} in diameter, stellately many times divided, closely attached to the soil; divisions of the thallus narrow (1–1.5^{mm}), spongy-cellular, the surface broken with deep irregular pits, yellowish green or reddish, especially at the margins, the ultimate divisions much crowded and often overlapping, naked at the margins and underneath; capsules deeply imbedded in the spongy thallus, not apparent above but the spores ultimately break through the upper side of the thallus; spores 90–127μ in diameter, black, opaque, slightly reticulate-rugose, with a narrow margin which gradually disappears with age.

Lower California, 1892. *(T. S. Brandegee.)*

The species north of Mexico may be separated by the following table in which spore characters, hitherto not recorded, are utilized in separating species, although wherever possible the characters of the thallus have been employed in order to make possible the discrimination of material in the sterile condition. *Riccia bifida* and *R. Beyrichiana* are omitted as there is no recent evidence that they are members of our flora.

Thallus with large air cavities which communicate with the upper surface. (SPONGODES Nees.)

Upper surface of thallus spongy, pitted, green or tinged with purple . . . . *R. crystallina* L.
Upper surface of the thallus mostly smooth except for the median groove; divisions long, yellowish green . . . . *R. lutescens* Schw.

Thallus solid, mostly without air cavities. (LICHENODES Bischoff.)

a. Thallus without scales or cilia on the margins or underneath.

i. Spores medium size or small (at least under 100μ).

1. Thallus only slightly reticulate above or not at all.

* Spores small (60μ or less).

Thallus with wide divisions, thin and flat; spores muricate-spinulose . . . . *R. tenuis* Aust.
Thallus with narrow divisions.
Spores obscurely muriculate . . . . *R. Frostii* Aust.
Spores coarsely reticulate . . . . *R. Huebeneriana* Lindenb.

* * Spores larger (75–95μ).

Divisions of the thallus broad; spores nearly opaque, with large reticulations . . . . *R. Catalinæ* Underw.
Divisions of the thallus narrower; spores dark fuscous with deep reticulations (about 8 across convex surface). . *R. arvensis* Aust.

2. Thallus glaucous or white, clearly reticulate-papillose.

Spores brown, 65–80μ, reticulate . . . . *R. glauca* L.
Spores unknown: thallus milk white above . . . . *R. albida* Sulliv.

ii. Spores very large (130–170μ) black, opaque.

Thallus very large, 4–7^{mm} wide . . . . *R. Donnelli* Aust.

b. Thallus scaly underneath, not ciliate.

i. Scales and usually the thallus purple underneath.

Thallus simple or forked: spores light brown anastomose-reticulate . . . . *R. nigrella* DC.
Thallus 1–3 dichotomous; spores nearly black, finely reticulate, almost opaque . . . . *R. aggregata* Underw.

ii. Scales usually whitish; thallus green underneath.

Spores light brown, 84–94μ; scales reaching beyond the margin. *R. lamellosa* Raddi.
Spores dark brown, 64–70μ; scales not reaching the margin. *R. minima* L.

c. Thallus ciliate at the margins or apices.

i. Spores black or nearly so.

Thallus small; spores (about 85μ) reticulate with 10–12 areolæ across the surface . . . . *R. ciliata* Hoffm.
Thallus larger; spores 92–108μ; opaque, scarcely reticulate. *R. hirta* Aust.

ii. Spores brown.

Thallus simple or bifurcately lobed, spores 84–92μ. *R. tumida* Lindenb.
Thallus stellate or fan-shaped, forming rosettes.
Spores 68–73μ; faintly reticulate with 12–14 areolæ across the convex surface . . . . *R. Californica* Aust.
Spores 85–110μ, reticulate with 7–8 areolæ across the convex surface . . . . *R. Lescuriana* Aust.

The following geographic distribution shows rather the paucity of our information than the real limits of the range of most of the species. Six species are known only from California, viz.: *RR. aggregata, Californica, Catalinæ, ciliata, glauca and tumida.*

R. Donnellii is known only from Florida.

R. albida is known from Texas and Louisiana; *R. hirta* from New Jersey and California.

R. nigrella is known from California, New York and Pennsylvania; *R. Hubeneriana* from Massachusetts, New Jersey and Ohio; *R. Lescuriana* from New Jersey, Florida and Illinois.

R. lamellosa is known from Ontario, New Jersey, Alabama and California.

R. arvensis from Connecticut, New Jersey, Ontario and District of Columbia; *R. crystallina* from Illinois, South Carolina, Colorado, and Nevada.

R. minima is known from New York, New Jersey, South Carolina, Illinois and California, *R. tenuis* from New Jersey, Delaware, Ohio, Missouri and Arkansas.

R. Frostii is known from Ohio, Illinois, Missouri, Kansas, S. Dakota, Idaho, Montana, and Colorado.

R. lutescens leads the list, being known from Massachusetts, New York, Virginia, Tennessee, Louisiana, Ontario, Ohio, Illinois, Minnesota and Idaho.

From 21 states there are no Riccias reported and fourteen others have reported each a single species.[2]

The above showing would strongly point to the fact that there is need of much local observation before we can form any rational idea either of the extent of the genus as developed in America or of its geographic distribution.

Greencastle, Indiana.

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[2] *Ricciocarpus natans* and *Ricciella fluitans* formerly included in this genus have a much more extended distribution.

Pleodorina, a new genus of the Volvocineæ.[1]

WALTER R. SHAW.

WITH PLATE XXVII.

In September, 1893, the writer collected at Palo Alto, California, a Volvox-like alga, which Dr. D. H. Campbell at once suggested was different from any described genus. Subsequent review of available literature on the subject at Stanford University and by Dr. W. G. Farlow and Mr. B. M. Davis at Harvard University, brings to light no mention of a similar form. The plant is a so-called "cœnobium" of about 128 biciliate cells, one-half to two-thirds of which are, in the non-sexual form observed, "parthenogonidia." In view of its apparent affinity with *Pandorina* and *Eudorina*, the larger number of cells, and the differentiation of the cells into two kinds, the name *Pleodorina* seemed appropriate and was adopted.

The first specimens were collected Sept. 19, 1893, in an irrigation ditch at Palo Alto, and others were taken from the same place at intervals of a few days for about two weeks. They were kept in a wide bell-jar until Oct. 13th, when they suddenly disappeared before a swarm of insect larvæ. The living specimens from which drawings were made were held in place under the microscope by allowing the cover-glass to press upon them slightly. An attempt was made to determine the time required for the full development of the gonidium-bearing individual from the gonidium by isolating mature plants in watch glasses; but the daughter plants were not healthy, and did not come to maturity.

The typical specimens are those in which the gonidia have reached their full size previous to division. Such individuals are spherical (fig. 1) or more often ellipsoidal, and measure 187–258μ in long diameter;[2] the short diameters of ellipsoidal specimens measure 7–20μ less. With one exception the number of cells in those counted varied from ninety-eight to one hundred and twenty-six; the exception numbered sixty-three

[1] Prepared under the direction of Dr. Douglas Houghton Campbell.

[2] Most of the measurements and also the counts of the cells given here are taken from specimens permanently mounted in 25% glycerine after fixing and staining.

cells. The cells are situated in the periphery of the sphere, of which the gonidia occupy a hemisphere or more and the vegetative cells the remainder. The centers of the two areas thus distinguished coincide with the ends of the long diameter in ellipsoidal specimens. The vegetative cells are about 12μ in diameter, and the gonidia just before division 25–30μ. Each vegetative cell (in young individuals the cells are all alike) is oval, with the smaller, clearer end directed outward and bearing two cilia which project through the gelatinous envelope. In each cell a pyrenoid and a red pigment corpuscle are conspicuous, the latter situated on the surface near the forward or outer end (figs. 5 and 7). The pyrenoid is in the inner end of the cell and appears to lie within the center of the single chromatophore, the edges of which extend forward around the periphery of the cell. Specimens fixed with 1% chromic acid, washed, stained with hæmatoxylin and afterward with alum cochineal, show in each cell a centrally located nucleus with a well defined nucleolus (figs. 7 and 8). Some young specimens fixed with picro-nigrosin show a vacuole in the hyaline forward end of the cell.

A number of specimens were fixed and stained with a view to ascertaining whether any protoplasmic connection exists between the cells. After fixing on the slide with 1% chromic acid, some were stained with safranin, Bismark brown, alum cochineal and haematoxylin. Others were fixed and stained with picro-nigrosin, but in no case did any connecting threads appear. At the time when these observations were being made, the writer met with a specimen of *Volvox minor* Stein, and here the connecting threads between the cells were visible in the living plant under a magnification of only 57 diameters and without the use of any stain. In the young of *Pleodorina* the cells are all of the same size and apparently alike, but in the older ones the gonidial cells become gradually larger, and then more spherical and finally even slightly flattened. The granular cell-contents increase; the pyrenoids increase in number, and the red pigment corpuscle becomes less conspicuous and disappears.

The movement of the plant in the water was followed in the case of a few individuals bearing well developed gonidia. In swimming through the water the vegetative pole is directed forward and the plant revolves to the right (in observed cases) on the axis connecting the vegetative and reproductive poles.

The path is parallel to this axis in upward vertical as well as in horizontal movement.

The division of the gonidia was followed in a number of cases on different days. The first cell division took place about two hours after noon and the daughters escaped from the mother plant eighteen to twenty-four hours afterward. Previous to division the investing membrane of the cell begins to swell up and withdraw from the protoplasm, doing so at first in a zone just back of the point of attachment. This for a time gives the forward end of the cell the form of a beak (fig. 6). The two cilia persist on the gonidium and are active even after the cell has divided several times. The succession of divisions is essentially as in *Eudorina elegans.*[3] The first two divisions are perpendicular to the surface of the whole sphere and to each other (fig. 2, *a–c*). Before the next division takes place the walls already formed become curved and oblique, so that seen from the front the cells overlap slightly (fig. 3, *d*). The next division is anticlinal and somewhat oblique (figs. 2, *d* and 4, *b*). As the division proceeds a plate of cells is formed which becomes concave from the front (fig. 4, *c*); the concavity increases until the plate becomes bowl shaped, and the mouth of the bowl closes to form a hollow sphere of very closely arranged cells before the last division takes place.[4] The cells separate slightly and become rounded; then the last division into about 128 cells occurs and the cells are again closer and flattened by contact. Finally the cells become gradually more and more separated from each other, though fixed in the common envelope.

After the last division takes place the cilia begin to form as outgrowths, two from the outer end of each cell. Thus it is to be borne in mind that the cilia do not arise on that end of each cell which corresponds to the ciliated end of the mother gonidium, but on the opposite end. As the cilia become longer they acquire movement and each daughter plant rotates slowly within the swelled up membrane of the gonidium from which it has developed. The daughter plants escape as spheres of cells which are all alike. One case was observed in which the formation of the cilia began before the young plants had reached the spherical stage. This was in the above mentioned sixty-three-celled plant. In this in-

[3] Goebel, Outlines of Class. and Sp. Morph. of Plants (Eng. Trans.) 37. 1887.
[4] Beyond this point the transition was not actually followed but traced by different stages present in each of two fixed mother plants.

stance the daughter plants, 39 in number, consisted of about 64 cells each (maximum estimate). Usually one or two of the gonidia fail to undergo division, and occasionally there are one or more cells in the reproductive area which do not even increase in size.

In comparing this plant with others of similar type it is reasonable to suppose that there is a sexual generation yet to be observed.[5] If we consider that *Gonium*, *Pandorina*, *Eudorina*, and *Volvox* represent a near approach to a true line of ascent, we have then in *Pleodorina*, so far as we can judge with no knowledge of its sexual generation, a new member of the series intermediate between the latter two, but much nearer to *Eudorina*. Its close affinity to *Eudorina* is indicated by the absence of any discernible protoplasmic connection between the cells as well as by the mode of development of the individual from ciliated gonidia. It resembles *Volvox* more than *Eudorina* does in the number of cells composing the individual and the specialization of certain cells for the purpose of reproduction. Thus we may expect in the sexual generation a degree of differentiation which shall be a step higher than that of *Eudorina* and nearer to the latter than to that of *Volvox*.

With our present knowledge we may briefly describe the subject of these notes as follows:

PLEODORINA, gen. nov.—Plant body a hollow, spherical or spheroidal "cœnobium" of green biciliate cells fixed in a hyaline gelatinous envelope. Red pigment spot in each cell. No connecting filaments between the cells. Non-sexual reproduction by gonidia; gonidia formed by increase in size of part of the cells; daughters escape from mother plant as spheres of similar biciliate cells. Sexual reproduction not known.

P. Californica, sp. nov.—Number of cells composing the plant body approaching 64 or 128; usually about 120. Plant body about 175–300μ maximum diameter. Cells oval; smaller end hyaline and bearing two cilia which project through the envelope; each cell containing a red pigment spot, nucleus, chromatophore, and pyrenoid. Vegetative cells about 12μ in diameter; cilia several times as long as cells. Non-

[5] Up to date of present writing, April 7, 1894, no more of the plants have been collected.

sexual reproduction by development of one-half to two-thirds (50–62%) of the cells into gonidia which retain cilia until ready to divide or longer. Diameter of gonidia 2–3 times that of vegetative cells. Each daughter plant enclosed within the swelled membrane of its mother gonidium until it becomes independent; active before escaping; all cells alike at time of escape. Sexual reproduction not known.

Habitat: Fresh water ditch, Palo Alto, California. Autumn.

Stanford University, California.

EXPLANATION OF PLATE XXVII.

Fig. 1. Typical plant of 120 cells; from life; cilia diagrammatic and added afterward from fixed specimen; × 178.—Fig. 2. Successive stages of division of gonidium, front view; *a*, 2:50 P. M.; *b*, 3:20 P. M.; *c*, 4:15 P. M.; *d*, 5:05 P. M.; *e*, 5:40 P. M.; *f*, 10:15 following morning; cilia here also diagrammatic; × 337.—Fig. 3. Another gonidium from same mother plant; lighter central area indicates hyaline portion of cell; *d* shows obliquity of dividing walls; *a*, 2:45 P. M.; *b*, 3:25 P. M.; *c*, 3:40 P. M.; *d*, 4:50 P. M.; × 337.—Fig. 4. Side view of another gonidium from same mother plant; *a* shows only one of two cilia which were present in full size and active; *a*, 2:20 P. M.; *b*, 3:15 P. M.; *c*, 4:35 P. M.; × 337.—Fig. 5. Two vegetative cells from same plant to show relative size; cilia as in fig. 1; × 337.—Fig. 6. Two gonidia just previous to division, × 337.—Fig. 7. Vegetative cell showing pigment corpuscle; chromic acid 1%, and safranin; permanent mount in glycerine; × 1,000.—Fig. 8. Vegetative cell showing chromatophore surrounding pyrenoid; chromic acid 1%, and hæmatoxylin, afterward stained with alum-cochineal; permanent mount in glycerine; × 1,000.—Fig. 9. Two gonidia showing nucleus and pyrenoids in each cell; same specimen as fig. 8; × 1,000.

All drawings sketched with an Abbé camera; *pyr.* = pyrenoid; *nu.* = nucleus; *pig.* = pigment spot.

Noteworthy anatomical and physiological researches.

The fixation of free nitrogen by plants.

A review of the question of the assimilation of free nitrogen must of necessity be somewhat disconnected as different investigators approach the subject from such different standpoints, some dealing entirely with the economic phase while others treat its biological aspect.

The present synopsis deals mainly with the literature of the year 1893, including only those papers of the previous year that throw light upon concluding investigations.

Research on this question has not been as active during the past year as in preceding years, and in a number of cases papers are only concluding pieces of work undertaken earlier. The general trend of the whole subject, broadly considered, has been much more in the line of general physiological experiment than in the morphological study of the agent of nitrogen fixation.

Assimilation by non-leguminous plant organisms.

Concerning the question as to what organisms are able to utilize uncombined nitrogen, several papers have appeared.

Frank's contribution to the subject in showing that some of the algæ possess this ability seems now to be settled beyond dispute. Schlœsing and Laurent [1] experimented upon this question, using both the direct and indirect methods of nitrogen determination and found that not only were the green algæ able to fix gaseous nitrogen but that some of the mosses possessed this peculiarity in a marked degree. Koch and Kossowitsch [2] have repeated this work with green and blue green algæ, using purely inorganic solutions and have arrived at the same conclusion. While the number of experiments upon this point seem to show conclusively that the lower green forms of vegetable life possess this power, yet it would seem desirable if experiments were also carried out with pure cultures of various forms and thus thoroughly exclude all possible chance for misinterpretation of results.[3]

[1] Ann. Inst. Past. **6**: 110. 1892.–Comptes rendus Acad. **115**: 732. 1892.

[2] Bot. Ztg. **51**: 342. 1893.

[3] Some of Schlœsing and Laurent's experiments were carried out on approximately pure species but they were not grown in sterilized culture media.

The importance of algal assimilation, for so long a time overlooked, is by no means inconsiderable, for it doubtless will enable one to harmonize many results that heretofore seemed inexplicable. Particularly is this true with experiments carried on in natural soils with non-leguminous phanerogams, where the nitrogen claimed to be assimilated is always relatively small.[4]

In regard to chlorophylless organisms, Berthelot[5] has recently studied several soil bacteria in pure culture, *Aspergillus niger*, *Altenaria tenuis*, and a Gymnoascus, using for a culture medium, humic acid and kaolin. With these forms he was able to detect a marked increase in the nitrogen content. The bateria of lupine tubercles grown in humic acid and Cohn's solution increased the amount of fixed nitrogen by fifty per cent. He also noted that when the amount of combined nitrogen becomes large, the organisms utilize this rather than continue to fix the elemental gas.

Winogradsky[6] has issued a preliminary paper upon the ability of bacteria to function as nitrogen collectors. He worked under bacteriological conditions, using for a culture medium a non-nitrogenous but fermentable solution (pure dextrin and specially prepared mineral salts). With this medium, he isolated one well characterized bacillus able to form gas and produce butyric acid in quantities. It would grow neither on gelatin nor on gelatinized silica to which sugar had been added. In general, it bore a strong resemblance to Fitz's *B. butylicus*.

While the evidence at hand as to the ability of lower organisms to utilize atmospheric nitrogen seems to be fairly complete, it is not so definitely settled whether the same is true for higher plants, excluding of course the legumes. Frank has persistently maintained the view that the ability of fixing nitrogen was a function of protoplasm and was resident in the higher plants as well as the simpler. Especially is this marked, he claims, in thrifty, vigorous plants in the growth subsequent to the seedling stage. He has found, repeatedly, a marked increase in the nitrogen content of soil and crop where non-leguminous plants such as rape, oats and

[4] Note in this connection the results of Schlœsing and Laurent, Ann. Past. **6**: 110, in which a fixation of ·N was observed with oats, cress and mustard, where algal vegetation flourished, but where this was excluded no gain could be detected.

[5] Comptes rendus Acad. **116**: 842. 1893.

[6] Comptes rendus Acad. **116**: 1385. 1893.

mustard were used. In his last paper,[7] he brings together the results of several experiments made during the last few years, in which is shown a gain in N, both in crop and soil, over what was in the seeds and soil at the beginning. Frank's methods are not given in sufficient detail to enable one to judge of his results critically; in fact this charge has been made repeatedly against many of his observations.[8] He uses mainly the indirect method of nitrogen determination, planting the seeds in a soil containing a known quantity of fixed nitrogen and then determines by analysis the content of the soil and crop. If the sum at the end exceeds the total amount available at the beginning, he reasons that the plant has assimilated gaseous nitrogen. A control pot with unplanted soil is usually analyzed to see if there is any change in the fixed nitrogen of bare soil. As his experiments are usually carried out on unsterilized soil and his unplanted check soils often show a gain in fixed nitrogen, there is hardly any doubt that the N-increase in his experiments with non-leguminous plants is in part due to fixation by lower organisms, algæ, fungi, or bacteria that are common to the soil.

Kreusler[9] points out a serious objection to his methods of analysis as not sufficiently accurate to discriminate in the case of non-leguminous plants where such small increments are to be noted.

In the résumé above referred to two experiments with non-leguminous phanerogams are given which were made in absolutely N-free land, the results of which are as follows:

Sinapis alba (4 plants): grams of N in seed, 0.0012; in crop, 0.0043.
Solanum tuberosum (4 pieces): grams of N in seed, 0.022; in crop, 0.2186.

He also describes a still more recent experiment, made with *Sinapis alba*. In this case he used large bell jars and although the plants did not develop normally (they were unable to unfold their flower buds in this closed space), he found a certain amount of nitrogen fixed.

The N content at beginning was as follows:

Three seeds, 0.0009gm; soil, 0.162%;

at close of experiment,

Crop, 0.0507gm; soil of pot, 0.215%; soil of control, 0.195%.

[7] Bot. Ztg. **51**: 150. 1893.
[8] Journ. f. Landw. **41**: 144. 1893.
[9] Bied. Cent. **21**: 257.

Frank claims that the results reported by Liebscher[10] with mustard are in general confirmatory of his experiments. This latter investigator worked under field conditions and claims that upon rich soil white mustard can collect twice as much nitrogen as thrifty peas, beans or clover. Liebscher's paper is very full and explicit as to methods and details but his experiments were conducted under such conditions that the different factors were not controlled, hence the value of the conclusions is much lessened. He concludes that the ability of collecting nitrogen is present with certain non-leguminous plants (mustard and oats) but only when they are growing under optimum conditions. In rich unsterilized soil, peas do not increase in thriftiness even if they are fed with combined nitrogen, while the non-leguminous plants are much benefited by such a treatment.

Liebscher thinks that errors of analysis will hardly explain the quantity of nitrogen apparently collected by the oats and mustard but as he admits, no control was exercised over the rainfall or the water used for watering, neither was the influence of algæ or soil organisms taken into consideration.

It would seem that while there may be an increase in the nitrogen under field conditions that may possibly possess some economic value, yet from the standpoint of physiology, these experiments are not sufficiently conclusive to prove that the higher plants themselves were able to fix the nitrogen.

Lotsy[11] has recently studied this question relative to the mustard assimilation in a careful way, employing both sand and water cultures in sterile and unsterilized condition, and from his work concludes that neither *S. alba* nor *S. nigra* are able to live without combined nitrogen. In this connection it is only necessary to refer to the exceedingly careful researches made previous to this by Schlœsing (fils) and Laurent[12] in which they showed by a comparative set of experiments, by both direct and indirect methods of analysis, that white mustard, oats, cress, and spergula were unable to assimilate free nitrogen.

In 1890 Petermann[13] affirmed that barley was as efficient a nitrogen collector as beans. Since then he has published a second paper[14] giving full details of his experiments. His

[10] Journ. f. Landw. **41**: 180. 1893.
[11] Bull. O. E. S. Dept. of Agriculture *18*.
[12] Ann. Inst. Past. **6**: 114. 1892.
[13] Mém. Acad. roy. de Belg. **44**: 1889.
[14] Mém. Acad. roy. de Belg. **47**: 1892.-Abs. in Chem. Cent. **2**: 988. 1893.

plants were grown in natural soil, under normal atmospheric conditions, and also in air freed from combined nitrogen. His results showed a marked gain with barley in normal air, and somewhat less increase in air freed from fixed nitrogen. The N-content of seed, water added, drainage water, and crop were carefully determined but as he himself says, the factor of unsterilized soil does not exclude the possibility that lower organisms may have functioned in the capacity of nitrogen collectors. He has since repeated his experiments,[15] using both natural and sterilized soils, and arrives at a different conclusion. In unsterilized unplanted controls, having, however, evident algal growth, a slight gain was noted. In sterilized unplanted soil and soil sown to barley a slight reduction was found. This corroborates Schlœsing's results and shows that the increase sometimes ascribed to arable land is really due to its living organisms. Unfortunately, the experiment in unsterilized soil planted to barley was lost, but the fact that the sterilized soil planted with barley lost a part of its N shows that the supposed gain in the previous series was really due to soil organisms of a lower type.

In Frank's last paper,[16] already referred to, he presents his views in a compact and well digested form, citing experiments of his own, some of which are detailed for the first time, and critically reviewing the work of other investigators. He regards the experiments carried on in closed glass spaces as unnatural inasmuch as the conditions are so abnormal that the plant is unable to fruit. As he claims that the nitrogen assimilation of non-leguminous plants can only take place when the plant is thrifty and vigorous, this objection seems well founded. As conditions more nearly approaching those of the open air necessarily embrace influences that must be considered, it would seem that the only way to settle this question is to carry out simultaneous experiments under various conditions by both direct and indirect methods and then correlate the results.

Frank summarizes his results as follows:

1. The legumes can assimilate free N without the intervention of the symbiotic organism.

The strongest case he cites to prove this is the experiment made with four plants of *Robinia pseudacacia* in N-free steril-

[15] Bull. Acad. roy. de Belg. **25**: 267-276. 1893.
[16] Bot. Ztg. **51**: 139. 1893.

ized sand, in which an increase in nitrogen from 0.0024^{gm} to 0.0538^{gm} is noted. This experiment he regards as fatal to the theory of Hellriegel, inasmuch as this legume without tubercles on its roots can materially increase its nitrogen supply.

2. The symbiotic microbe isolated from a leguminous plant thrives luxuriantly on organic N but barely lives when it derives its N from the air.

In this view he is opposed more or less strongly by Prazmowski,[17] Laurent,[18] Beyerinck,[19] and Bertholot,[20] all of whom maintain that pure cultures of the tubercle organisms take up quantities of uncombined nitrogen.

3. The quantity of combined N in root tubercles does not suffice to account for the N in remaining plant organs.

He takes the analyses of five plants of *Lupinus luteus* and determines the N-content of the tubercles, the aerial organs and the roots proper and shows that at no time during the development of the plant do the tubercles contain more than a fraction of the nitrogen that is present in the plant. Unless the tubercles yield up a continuous supply of N, which has never been claimed as taking place, it is hardly possible to account for the N supply of the plant unless the plant itself takes part in the assimilatory process. As the samples selected were taken from an open field, the conditions are such that the conclusion is hardly warranted that the plant itself assimilated a large part of the nitrogen. Frank's own experiment with this same plant in sterilized soil (sand) only showed with six plants an increase from 0.042^{gm} in seed to 0.3475^{gm} N in crop, so that the factor of soil and its organisms seems to be more important than anything else even in his own experiments.

4. The non-leguminous vegetable organisms can assimilate free nitrogen.

To show how wide spread is this function, he classifies examples under the following heads, including:

(*a*) fungi, quoting as an example a ten months' culture of *Penicillium cladosporioides* in a nitrogen-free sugar solution as fixing 0.0035^{gm} of N;

(*b*) algæ and mosses;

(*c*) phanerogams;

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[17] Landw. Versuchst, **38**: 5. 1891.
[18] Ann. Inst. Past. **5**: 135. 1891.
[19] Bot. Cent. **52**: 137. 1892.
[20] Comptes rendus Acad. **116**: 842. 1893.

citing a résumé of the experiments he has made with different plants. He also quotes confirmatory evidence from Liebscher and Petermann that may now be disregarded or at least considered of very doubtful value.

5. How far is combined N (nitrate), if used as a manure, utilized by the plant and what becomes of it in the soil?

Frank holds that this subsidiary question should also be considered in a discussion of the nitrogen question. Most agriculturists affirm that if plants are fed with increasing amounts of nitrates a corresponding increase in N will be found in the crop. Frank planted mustard in N-free soil to which definite amounts of $Ca(NO_3)_2$ were added.

The seed contained .0003^{gm} and the soil .061^{gm} in the form of the salt, while the crop showed .051^{gm} N and no trace was found in the soil. An unplanted check soil containing .061^{gm} at the same time contained only .0046^{gm} N, thus showing that there is a large loss that is of no use to the plant.

Repeating a part of the experiment with unplanted soil pots to which a definite amount of the nitrate had been added, a large portion of the nitrogen was found to have disappeared. This disappearance he thinks is due to activity of micro-organisms of the denitrifying type as shown by Breal,[21] Schlœsing and others, but it shows that the increased amounts of N furnished in a manure may not reappear in the crop. They serve to make the plant more thrifty in the beginning and thus increase its ability to utilize free nitrogen. For this reason it is necessary to furnish combined nitrogen to non-leguminous plants during the germinating period while the legumes on the other hand can forego fixed nitrogen from the first, owing partly to their highly albuminous seeds and partly to the symbiotic relations that they maintain with the tubercle organism by means of which the assimilatory activity of the plant is largely increased.

The actual fixation of nitrogen by legume tubercles.

Concerning the ability of legumes to acquire free nitrogen there is no diversity of opinion, but just how these plants fix this gaseous element is not so definitely known. The generally accepted idea that the process bears an intimate relation to the presence of root nodules is no doubt correct in the main, but whether the nitrogen is fixed by the nodule organ-

[21] Comptes rendus Acad. **114**: 681. 1892.

ism or the plant itself or is a partnership act is by no means settled.

The most important contributions to this phase of the question that have appeared in the past year are the joint papers of Nobbe and Hiltner.[22] In their several papers, covering experiments since 1890, they show concordant results. They hold that the assimilation of nitrogen by legumes bears a direct relation to the formation of bacteroids. In numerous cases they found that plants (peas) growing in good soil and well supplied with nodules were unable to make much gain. When inoculated with pure cultures of *B. radicicola*, some plants would gain largely in nitrogen while others would apparently suffer from nitrogen hunger. When the tubercles on these plants were carefully examined they noted that the nodule-producing organisms were unchanged in those plants that hungered for nitrogen, while in the thriftier ones, the bacteria were changed into bacteroids. They conclude that (1) tubercles in which bacteroid formation does not occur are injurious instead of beneficial to the host plant, (the unchanged bacteria are then merely parasites); (2) the unchanged bacteria present in tubercles seem to have no relation to the nitrogen fixation by legumes; (3) the more vigorous the bacteria the less tendency there is toward bacteroid formation; (4) the assimilation of N begins with the formation of bacteroids.

In some experiments with Robinia they obtained striking results. The plants gained more nitrogen in the end when cultivated in nitrogen-free soil than in soil containing nitrogen. This was because there was a more complete conversion of the bacteria into bacteroids in non-nitrogenous soil than where nitrates were present. Manuring with nitrates causes a more rapid development of the plants at first, and with this a more rapid growth of smaller nodules, but these were of less benefit than the larger nodules noted in nitrogen-free soil, the bacteria of which were entirely changed into bacteroids.

The formation of bacteroids in the light of this view will have then an increased interest.

Nobbe and Hiltner claim that the bacteroids are formed by repeated division of the tubercle germ without the separation into isolated individuals. This continued division usually

[22] Sächs. landw. Zts. *16:* 165. 1893. Landw. Vers. Stat. **42**: 459. 1893.

takes place transversely, and this produces an elongated growth although lateral protuberances often arise making a branched and irregular appearance. They liken the swollen branched bacteroids to a gill respiration, the nitrogen being absorbed by the water and this coming to the absorbing surfaces in a dissolved condition. The fact that nodules are less active in their assimilatory capacity in water cultures than in soil is commented upon and the inference drawn that the slower exchange of gases in the water than in capillary soil is the cause of this lessened activity.

Variety of species of nodule-producing organism.

Regarding the question as to whether there is a variety of species of the nodule forming organisms, Nobbe and Hiltner give some additional experiments in infecting different legumes with bacteria normally found in other species.[23] In nitrogen-free soils, certain plants like *Lupinus luteus*, *L. augustifolius*, *Acacia Lophantha* and *A. Julibrissin* produced tubercles when inoculated with bacteria of pea and bean tubercles. In soil containing nitrogen no infection could be noted, indicating that there must be a nitrogen hunger in the plant before the tubercle bacteria of one species of legume can penetrate the root system of another species.

Atkinson[24] records in his paper the failure to produce tubercles on *Dolichos sinensis* when inoculated with pure cultures isolated from *Vicia sativa* while this organism introduced into its normal host developed abundant tubercles.

The multiplicity of forms that have been noted among the bacteroids of different legume species has led to the view that there are specific forms for different species of legumes. This view receives support from a morphological basis but the uncertainty of a classification based upon a possible involution or abnormal structure is obvious.

Schneider[25] classified the tubercle organisms under the generic title of Rhizobium, adopting Frank's generic name. He based this classification at first on purely morphological characters as they appeared in the living tubercle, but he has since cultivated several forms artificially and has added cultural characteristics to his morphological data.

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[23] For earlier data on this question see Landw. Vers. Stat. **39**: 227-359. 1893.
[24] Bot. Gaz. **18**: 157. 1893.
[25] Ber. d. d. bot. Ges. **12**: 11. 1894.

Atkinson has suggested that the influence of the macro-symbiont upon the tubercle organism may have much to do with the variability of form as seen in the different types of bacteroids.

Bearing upon this question of variety of species are the very interesting observations of Bolley[26] on the natural distribution of tubercles on the roots of indigenous and introduced legumes of the western plains. The native flora of the region is distinctively leguminous and he gives a list of native forms that he finds well provided with tubercles under natural conditions of environment. Many of the introduced legumes, especially *Trifolium pratense* often fail to establish themselves in the Dakotas for some reason. On stray plants, self-seeded and alone, he finds few, if any, tubercles, even though they may be growing in the midst of the native leguminous forms, but when preceded by *T. repens* this form develops nodules on its roots and is apparently thrifty. Several other introduced legumes fail to produce tubercles when planted on the virgin soil.

The inability of these species to produce nodular outgrowths would seem to favor the theory that their special organism was lacking and therefore would indicate that there is a variety of species. These observations have, however, only a circumstantial value in lieu of actual infection experiments.—H. L. RUSSELL.

The influence of traction upon the growth of plants.

Hegler in a recent paper[1] points out some of the work done on this subject by other investigators: (1). Baranetzky concluded that the duration and intensity of growth were in no wise affected by traction. (2). Max Scholtz thought that the effect of traction was twofold: *(a)* a retardation which he considered a pathological effect; *(b)* an acceleration in which he saw the real mechanical effect of the traction. The author advances some important objections to these conclusions and then gives an account of his own investigations.

Method.—Two plants were used, one with and one without a weight. Measurements were taken by means of distance marks, microscope and micrometer, or by the Bara-

[26] Ag. Science 7: 58. 1893.

[1] HEGLER, ROBERT. Ueber den Einfluss des mechanischen Zugs auf das Wachsthum der Pflanze. Beiträge zur Biologie der Pflanzen, 6: 281. 1894.

netzky registering auxanometer. The curves of both plants were plotted together for comparison. Shoots, petioles and seedlings of the following plants were used. Helianthus annuus, Helianthus tuberosus, Phaseolus multiflorus, Tropaeolum majus, Tropaeolum minus, Ricinus bipinnatus, Linum usitatissimum, Cannabis sativa, and Dahlia variabilis.

I. By a series of experiments, using weights of 20–150^{gm} the conclusion is reached that the retardation of growth is to be regarded as a typical irritation phenomenon. An acceleration of growth takes place as soon as the weight ceases to act as a stimulus; but a new retardation can be produced by upsetting the equilibrium by an increase in weight.

II. The amount of weight necessary to produce a retardation varies in the same individual. Weights of 1.3–5^{gm} are sufficient to call forth a response in some plants, but others require still larger weights.

III. The retardation produced by traction is the greatest at the beginning of the grand period, diminishes towards the maximum, where it is almost nothing, and again increases as we descend the other arm of the curve. Large weights (150^{gm}) call forth a retardation even at the maximum of the grand period.

IV. The same is true for the daily period. If the irritability at the daily maximum is very low, the weight which before called forth a retardation, here produces an acceleration of growth. When a weight which has upset the equilibrium remains constant, the change of stimulus gradually ceases to work and to give place to the mechanical effect. A diminution in the weight also produces a retardation. The retardation then is dependent upon the abrupt change of weights, either an increase or a decrease.

V. By using etiolated specimens, the daily periodicity was avoided, when the retardation was not inhibited at certain phases but remained regular. The etiolated specimens were very sensitive to the weight as a stimulus.

VI. The approximate proportion given by Scholtz between the acceleration and the number of days is an inverse proportion between the weight and the amount of acceleration. For the same number of days the acceleration decreases with the increase of weight and passes with the high weight in the second to fourth day to a retardation of growth.

VII. A new retardation may be produced by a spontaneous increase of the sensitiveness to the stimulus; if it continues to increase, an inhibition of the growth in length must result.

VIII. The retardation is not produced by a depression of the hydrostatic pressure. The comparison of the turgor of cells from plants provided with weights and plants without weights showed a higher pressure in the plants subjected to traction. A similar retardation and increase in turgor was produced by gypsum jackets. In roots, especially, the pressure reached a considerable height and is perhaps of considerable biological importance. The investigations of Eschenhagen, Wortmann, and Zacharias are also analogous and showed with increase in turgidity, a retardation or inhibition similar to that produced by traction.—F. D. HEALD, *University of Wisconsin.*

BRIEFER ARTICLES.

Synchytrium on Stellaria media. (WITH PLATE XXVIII.)—Since Farlow and Seymour's Provisional Host-Index of the Fungi of the United States does not report Synchytrium on any species of Stellaria, it is possible that its occurrence upon *Stellaria media* Smith, in the vicinity of Baton Rouge, La., may be of interest to mycologists in this country.

Stellaria media is one of the most common weeds in and around Baton Rouge, and as early as the middle of January of the present year plants growing in low wet places were attacked by the fungus. The presence of the Synchytrium is first indicated to the naked eye by the appearance upon the host of blister-like swellings, each of which, a little later, shows in its center one or more bright yellow spots which, as the fungus matures, change to a reddish brown. The diseased areas show marked hypertrophy (figs. 1 and 2), and the cells of the host are deprived of their chlorophyll and finally of their entire protoplasmic contents. The lower internodes of the stem and the petioles and midribs of the leaves are favorite areas of attack, but if damp weather favors the development of the fungus, no aerial part of the host escapes, and the disease spreads to leaf-blades, pedicels of the flowers, calyx leaves, petals and even to stamens and pistils, everywhere swelling and distorting the tissue, dwarfing the growth and finally killing the plant.

A cross section of the stem where the spots in the pustules have turned reddish brown shows numerous resting-spores occupying cavities that are apparently much enlarged epidermal cells (figs. 1, 3, 4). The normal number of resting-spores in each cavity is one, though quite frequently two and even three are found, in which case they are usually somewhat reduced in size. The upper wall of the epidermal cell in which the spore forms becomes quite thin and often breaks and disappears entirely (figs. 3 and 5).

The resting-spores are spherical, thick-walled, reddish brown in color, with surfaces roughened by a deposit of coarse, irregularly shaped granules. Within this outer granular coat is a thick, darker brown, more compact layer; this has not the homogeneous appearance of most cell walls, but seen in section shows numerous thin, overlapping laminæ, no single one of which can be traced continuously around the circumference of the spore. Within the laminated coat is a colorless, rather delicate membrane enclosing a dark, granular substance that carries in it many oil globules (fig. 4). The resting-spores show considerable variation in size, and differ noticeably in the roughness of the outer surface.

Along with the resting-spores, though in separate cavities, are occasionally found sori composed of a varying number of angular, polyhedral sporangia enclosed in a delicate, transparent sac (figs. 6 and 7). Each sporangium has a thin, colorless wall and finely granular contents that are colorless when the sporangium is first formed, but change to a bright yellow as it matures.

A section through a leaf or stem where the disease is in its earlier stages shows many of the epidermal cells slightly enlarged and occupied by almost transparent spores that range in size from extremely small spheres to that of the average mature resting-spore. Now these may be early stages of either resting-spores or sori, but since in older diseased tissue, resting-spores are many times more numerous than sori, it seems probable that most of the immature bodies are resting-spores in process of formation (fig. 8).

The size of the resting-spores and their rough, reddish-brown covering agree with the description of *Synchytrium Stellariæ* Fuckel as given by Schroeter[1] and Fischer,[2] as do also the size of the sori and the variable number of sporangia. The host, too, is the same. The contents of the sporangia, however, are bright yellow instead of orange-red, but it is possible that those examined were not yet mature.

Schroeter states that in the same cavity with the sorus and lying just above it, is always found an empty membrane. He explains this as the original wall formed around the swarm-spore after it enters the epidermal cell of the host, and out of which, through an opening at its lower pole, the contents pass when ready to form a sorus. De Bary[3] mentions this membrane as indicating a possible sexual origin for the sorus, but thinks Schroeter's explanation probably the correct one. This may also explain the empty membrane represented in fig. 6.

Some of the resting spores, in their earlier stages, show a pouch like body closely adhering to the outer surface (fig. 9). It is barely possible that both sori and resting-spores result from the conjugation of the swarm-cells.

So far, all efforts to induce the resting-spores to germinate have been unsuccessful, and the writer is not able to state whether their contents first break up into sporangia, or pass directly into swarm-cells.—IDA CLENDENIN, *Baton Rouge, La.*

[1] Schroeter, Krypt. Flora Schles. Pilze, 189.

[2] Fischer, Rabenhorst's Krypt. Flora von Deutschland, Œsterreich und der Schweiz. 1: Abthl. IV. 52.

[3] De Bary, Comp. Morphol. and Physiol. of Fungi. 168.

EXPLANATION OF PLATE XXVIII.—Fig. 1. Section through two pustules on stem of Stellaria media. × 105.—Fig. 2. Cross section of healthy stem. × 105.—Fig. 3. Cross section of receptacle and resting-spore, the latter emptied of its contents. × 425.—Fig. 4. Resting-spore with outer thick coat broken and showing the endosporium. × 425.—Fig. 5. Surface view of epidermis of diseased part. × 425.—Fig. 6. Section through an upper internode, showing two sori in a common receptacle, one sorus emptied of sporangia. × 425.—Fig. 7. A larger sorus. ×425.—Fig. 8. Section through a younger pustule, showing an immature resting-spore or sorus. × 425.—Fig. 9. Young resting-spore with membrane attached to one side. × 425.

A peculiar malformation of an ovary and placenta on Begonia rubra-grandiflora.—Last spring while engaged in a series of cross fertilization experiments, I observed a very peculiar ovary and pistil in one of the flowers I had crossed. It was Begonia rubra-grandiflora and it had been fertilized by pollen from Begonia Verschafeltii with all the usual precautions against accidental fertilization from other sources. The ovary was superior instead of inferior, as it is normally. The four branches of the stigma seemed to be attached to the sides of the ovary near the base; or rather the ovary seemed to have grown up in the middle of the flower pushing the four branches of the stigma apart. The ovary also seemed to be turned wrong side out, exposing the parietal placenta on its outer surface, which was apparently covered with tiny whitish ovules. No capsule was developed below the base of the calyx, as in a normal pistillate blossom. These ovules or seeds could be seen very distinctly four or five days after fertilization, without a lens.

Unfortunately, after about ten days of growth, this peculiar ovary was accidentally broken off; but the stem was placed in water under a bell jar until the seeds became brown, and seemed ripe. Though the seeds seemed shrivelled when dry they were nevertheless planted; but none germinated.

This malformation was so curious (and so far as I could find unrecorded), that I would not trust my own observation, but showed the plant to several botanical students, and to Prof. A. S. Hitchcock, and Mr. M. A. Carleton, all of whom agreed with me that these small bodies on the outside of the ovary appeared to be seeds. Some were scraped off with a scalpel and examined under a microscope; and to all outward appearances seemed to be genuine seeds.

I have never read of a similar freak, so think this instance might be of interest to other botanists.—MINNIE REED, *Botanical Department, Kansas Agric. College, Manhattan.*

CURRENT LITERATURE.

Embryology of the Amentiferæ.

A recent paper[1] upon this subject, by Miss Margaret Benson, contains some remarkable results. Embryologists have long looked hopefully at the Amentiferæ as a possible fruitful field for the discovery of certain homologies of the phanerogamic embryo-sac. The results here recorded have been obtained from work that has been going on since 1891, in the botanical laboratory at Cambridge, at the suggestion of Professor Oliver. The material was difficult to obtain in the right stages and much time elapsed before satisfactory results could be obtained. The present paper is but preliminary and fragmentary, but it contains results that deserve announcement. British forms of Fagus, Castanea, Quercus, Betula, Alnus, Corylus and Carpinus are considered. A comparison is instituted with Treub's results with Casuarina, indicating the close affinity of that genus with the Amentiferæ. Treub, it will be remembered, considered the chalazal entrance of the pollen-tube a fact of sufficient importance to set off the chalazogams (represented by Casuarina) against all other phanerogams (porogams). It now seems that Alnus, Betula, Corylus and Carpinus are also chalazogams. The adaptations to this chalazal entrance are well pointed out. Other striking similarities are to be found in the development in the Amentiferæ of genuine "sporogenous tissue" in the nucellus, several similar contiguous cell-strands, from which one or more embryo-sacs are developed; and in the prevalence of cæca formed by the embryo-sac (tails of macrospores) which serve for the unimpeded pathway of the pollen-tube up the nucellus, as in Casuarina, or forage for the needs of the embryo, as in Fagus. It is a question for which of these purposes the cæca were originally acquired. In Castanea, also, there is a somewhat inconstant development of tracheids around the base of the embryo-sac, as in Casuarina, taken to suggest some ancestral organ. The remarkable branching and resting stage of the pollen-tube found in the group is also suggestive of Casuarina. No intimation as to the homologies of the antipodal cells or as to the nuclear fusion of the embryo-sac was obtained. The group is evidently one worthy of exhaustive study, and likely to bring us somewhat nearer the solution of the problem as to the genesis of phanerogams.

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[1] BENSON, MARGARET. Contributions to the embryology of the Amentiferæ, Part I. Reprint from Trans. Linn. Soc. II. **3:** 409–424. *6 pl.*

Minor Notices.

A LIST of the vascular flora of Rensselaer county, N. Y., has been published by Drs. H. C. Gordinier and E. C. Howe. The list enumerates 1345 species and varieties. The first list of the county was prepared by Professor Amos Eaton and Dr. George Marvin in 1819, under direction of the Troy Lyceum.

ANOTHER BULLETIN devoted to the "Russian thistle" (Salsola Kali tragus) has just been issued by the Department of Agriculture, having been prepared by Mr. L. H. Dewey of the Botanical Division. It gives an account of the introduction and spread of this weed, and suggests remedies. The map of present distribution shows that the Dakotas and Nebraska are chiefly infested, but dangerous looking patches are beginning to appear in Minnesota and Iowa.

A VALUABLE work for lichenologists is vol. I of "British Lichens" by Rev. Jas. M. Crombie, A. M. It forms the first half of a monograph of British lichens based on the collections contained in the British Museum. The large number of type specimens, not to be found elsewhere, and the very full collections from all parts of the British Isles have enabled the author to make his work unusually complete and valuable. The distribution of species is given very fully. A series of about seventy-five figures illustrate the general structure of the sixty-six genera described. The second volume is promised for next year.

THE FIRST PART of a preliminary revision of North American Cactaceæ by Dr. John M. Coulter has been issued by the Department of Agriculture. The work has been in hand since 1890, and has been conducted, with the help of various assistants, in the field, in the Engelmann collection of notes and types, and in the study of all accessible American collections. The nature of the material and the frequent loss of types have made the study exceedingly difficult; while the numerous garden names and descriptions of the older writers have made an inextricable synonymy. The Mexican boundary is disregarded, aud all species that have come under observation and are reasonably certain are included. The present part contains three genera: *Cactus*, replacing the generic name, Mamillaria, under which 64 species and varieties are defined, twelve of which are new; *Anhalonium*, with 4 species; and a new genus, *Lophophora*, proposed for Echinocactus Williamsii, with a species and variety. Geographical distribution is discussed, so far as meager information will allow, and a handy artificial key is provided for the species of Cactus. The numerous notes left by Dr. Engelmann, including descriptions of unpublished species, have added greatly to the value of the revision.

NOTES AND NEWS.

IN *Meehan's Monthly* (June) will be found a portrait of Dr. Wm. Baldwin.

IN *Erythea* (June) Mr. J. G. Lemmon describes and figures a new Pinus of S. E. Arizona, named from that "Apache-infested" region *P. Apacheca.*

STEPHEN ELLIOTT is honored in *Garden and Forest* (May 23) by a biographical sketch, with portrait, and also by a full description and figure of Elliottia racemosa.

PROFESSOR VON SACHS of Würzburg continues his physiological notes in *Flora.* The last note forms an exceedingly interesting paper of 28 pages, on mechanomorphoses and phylogeny (Flora —: 215–243. 1894).—BAY.

A TRANSLATION of Kerner's admirable *Pflanzenleben* has been made by Professor Oliver and Misses Busk and Ewart and is already in course of publication in sixteen monthly parts by Messrs. Blackie & Son, London and Glasgow.

THE *Journal of Botany* for June is largely devoted to tropical African plants, Mr. A. B. Rendle describing some new Asclepiads (one a new genus), and in connection with Mr. James Britten describing several new Convolvulaceæ.

MESSRS. MORRIS & WILSON of Minneapolis announce the publication of a translation of Dr. Walter Oels' little manual of experimental plant physiology by Mr. D. T. MacDougal of the University of Minnesota. We shall present a fuller notice of the book later.

IN THE *Kew Bulletin* (May) is published a list of fifty-two plants collected by Dr. W. L. Abbott, an American naturalist, on the Aldabra Islands (north of Madagascar), and named by Mr. J. G. Baker. The collection contains ten new species, but not a single fern, grass, orchid, or composite.

MR. CHARLES L. POLLARD publishes an enumeration of the Cassias of North America north of the Mexican boundary in *Bull. Torr. Bot. Club* for May. Twenty-seven species are recognized, two of which are new, both from the Gulf states. The synonymy of the genus seems to be remarkably simple and unvexed.

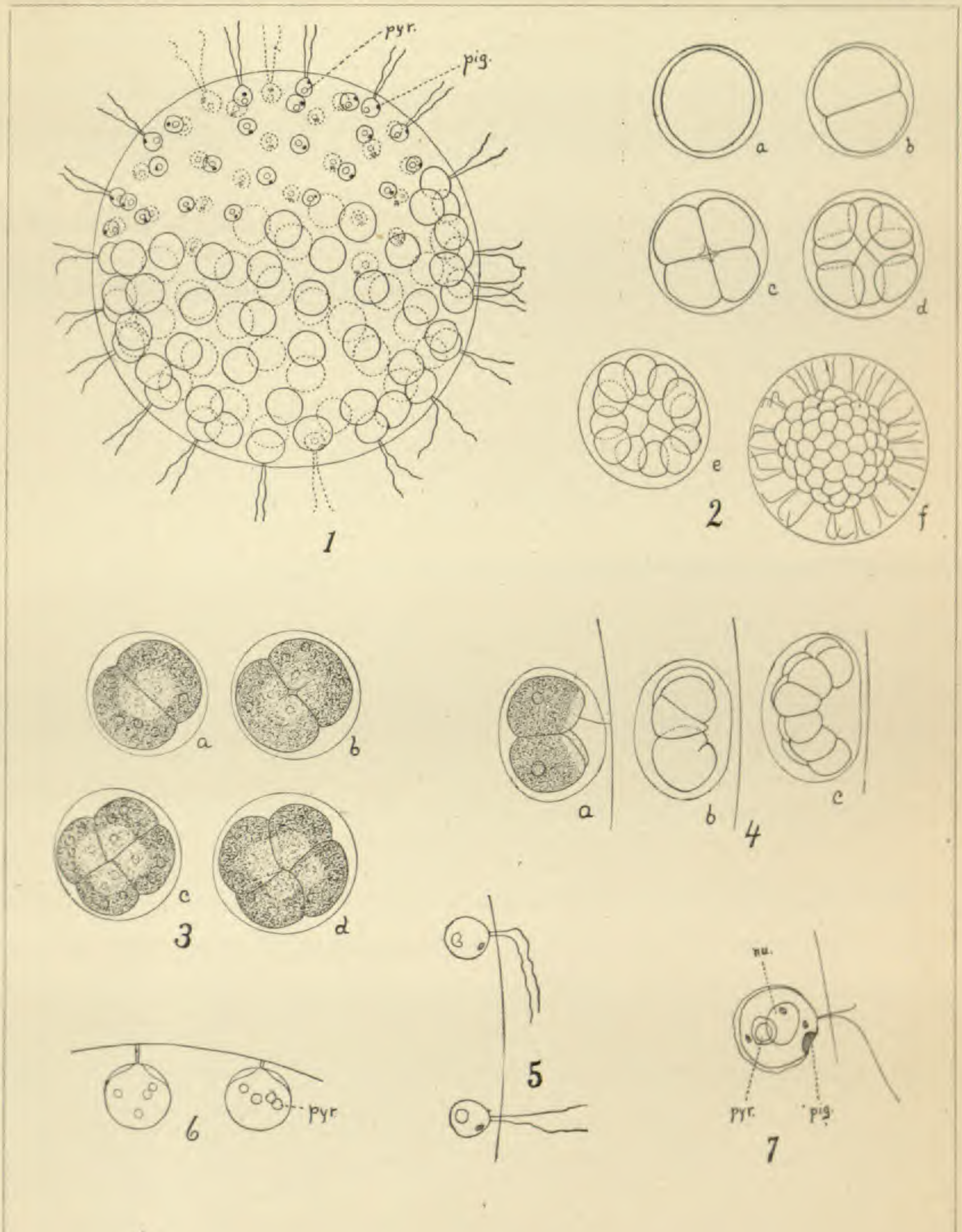
HEFT FOUR of the *Berichte* d. deutschen botan. Gesellschaft contains: Johann Bachmann, on the influence of external factors upon the formation of the sporangia of *Thamnidium elegans* Link; H. Potonié, on the position of the *Sphenophyllaceæ* in the system; J. Christian Bay, *Sachsia*, a new genus of the yeast-like fungi which does not cause alcoholic fermentation.—BAY.

THE *Bulletin de l'Herbier Boissier*, in recent numbers (April and May), published a series of botanical studies of the islands of the Levant by C. J. Forsyth Major and William Barbey; a comparative study of the genus Thunbergia by Charles Roulet; and new plants from the eastern slopes of the Caucasus, by N. Alboff, many of which have strong North American affinities.

IN THE *Bulletin* of the College of Agriculture of the Imperial University of Japan, (2: 1–33) is a paper by Prof. O. Loew, on the energy of living protoplasm. This paper outlines the history of protoplasmic action in view of the discoveries of Loew and Bokorny. Prof. Loew brings together a series of new facts about the occurrence and rôle of the active albumen, which he has found in very many trees, leaves as well as flowers.—BAY.

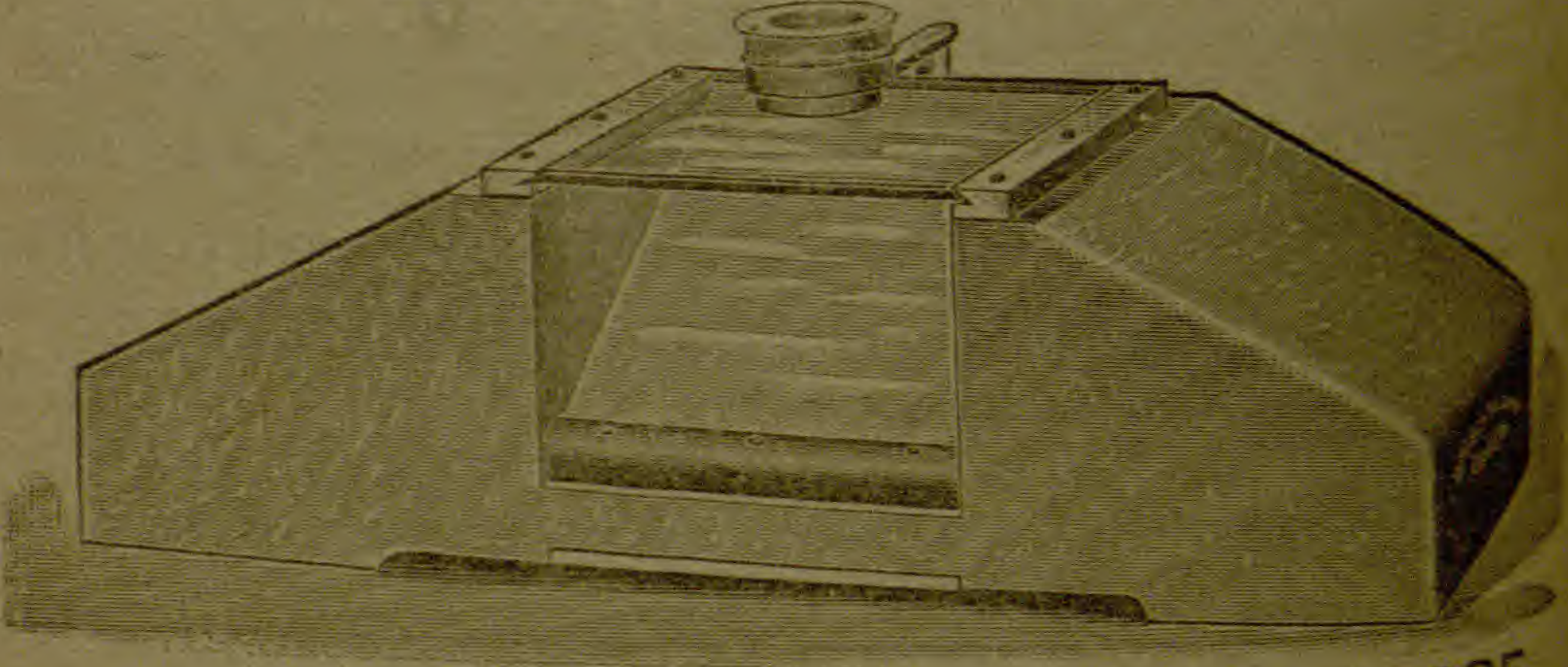
IN THE *Bulletin of the Torrey Botanical Club* (June) Dr. Britton publishes a revision of the genus Lechea, having succeeded Mr. Leggett in its study. The species are difficult to discriminate and hence have been much confused in collections, necessitating a study of the types, which have not always been forthcoming. Dr. Britton recognizes fourteen species. In the same number Mr. Bicknell separates *Helianthemum majus* (L.) from our H. Canadense, with which it has been confounded; Mr. Kearney describes several interesting plants from the southern states; and Professor Underwood describes a new Selaginella from Mexico.

THE FOLLOWING changes have occurred in addresses of botanists from January to June, 1894, in addition to those already noted in these pages: Dr. W. Saposchnikoff, formerly in Moskow, now at the University of Tomsk; Prof. F. Delpino has gone from Bologna to the Botanic Gardens at Naples; Dr. Giessler (Göttingen) was called to Lauterbach by Fulda as assistant in the Centralmolkerei; Prof. Zacharias of Strassburg was called to Hamburg as custos of the Botanic Gardens; Prof. Julius Klein is now at the Naples Zoological Station; Dr. W. Scott has gone to Mauritius as Director of Forests and of the Botanic Gardens; Dr. R. Otto, formerly at Berlin, is now at the Royal Pomological Institute at Proskau, O. S.; Dr. Fr. Krüger of Geisenheim took Dr. Otto's position at the Kgl. Landw. Hochschule at Berlin; Henry O. Forbes is now Director of the Museum at Liverpool, Eng.; Prof. O. Mattirolo is now at the Botanic Gardens at Bologna (instead of Prof. Delpino); Dr. C. Avetta is at Parma; Dr. Cesali is now first assistant botanist at the University of Rome; Prof. D. Lovisato has been called to the Botanic Gardens at Cagliari, as professor of botany; Arturo Baldini was elected custos of the Botanic Gardens at Bologna; G. F. Sarauw was elected assistant at the National Museum, Copenhagen, Denmark; J. E. Willis, recognized lecturer in Botany at Cambridge, was elected senior assistant in Botany and lecturer at Queen Margaret College in Glasgow, Scotland.—BAY.



SHAW on PLEODORINA.

CLENDENIN on SYNCHYTRIUM.



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THE BOTANICAL GAZETTE

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In the September number will appear:

A full report of the proceedings of section G, A. A. A. S., including the address of the vice-president, Dr. Lucien M. Underwood, and abstracts of the papers.

A report of the proceedings of the Botanical Club, A. A. A. S.

BOTANICAL GAZETTE

AUGUST, 1894.

Descriptions of new species of Uredineæ and Ustilagineæ, with remarks on some other species. II.

P. DIETEL.

WITH PLATE XXIX.

Chrysomyxa Arctostaphyli, n. sp.—Sori hypophyllous on red brown spots of about 4^{mm} diameter, arranged into groups, flattened, of irregular outline. Depth of the layers 160–240μ, spore cells oblong, about 18μ in diameter.

On *Arctostaphylos Uva Ursi*. Wisconsin, leg. Davis (no. 921), comm. Ellis.

Chrysomyxa Chiogenis, n. sp.—Spots yellowish or none; sori hypophyllous, scattered. Uredo layers appearing, when fresh, honey colored; uredospores formed in chains, ovate, 22–29×15–21μ, with colorless, coarsely verrucose membranes. Teleutosori orange-red, waxy, 95–120μ in depth, spores 8–12μ in diameter.

On *Chiogenes serpyllifolia*. Wisconsin, June, 1893, leg. Davis (no. 6,078), comm. Ellis.

By the dimensions of the spores this species is hardly distinguishable from *Chrysomyxa Pyrolæ* (DC.), but the uredospores on an average are smaller than in the last named species. Yet the sori do not occupy, as in this, uniformly the whole under surface of the leaves. Another difference, worthy of notice although small, consists in the structure of the membranes of the uredospores. In Chr. Chiogenis the tubercles, or, as DeBary has demonstrated, the prominent ends of the more dense staff-like portions of the membrane are thinner than in Chr. Pyrolæ. On the other hand the staff-like structure of the membrane is even more delicate in *Chr. Ledi* (Alb. et Schw.) and *Chr. Rhododendri* (DC.) than in our species under consideration.

Puccinia vulpinoidis D. & H., n. sp.—Hypophyllous, sori small, elliptical to linear. Uredospores obovate or elliptical, pale brownish, echinulate. Teleutosori long covered by the epidermis, afterwards erumpent, black; teleutospores clavate or fusiform, somewhat constricted in the middle, upper cell truncate or attenuated, often obliquely, thickened at the summit, lower cell cuneiform, clear brown, the apex being darker colored, epispore smooth, $40–65 \times 14–19\mu$. Pedicels persistent, about half the length of the spores.

On *Carex vulpinoidea.* Lafayette, Ind., Nov. 1888, leg. H. L. Bolley.

Puccinia areolata D. & H., n. sp.—Aecidia and teleutosori hypophyllous on pale spots of $1–2.5^{mm}$ diameter. Aecidia forming small irregular groups, pseudoperidia decaying, white, with torn edges, aecidiospores ovoid, about $25 \times 21\mu$, with colorless minutely verrucose membranes. Teleutosori scattered, dark brown, punctiform to 1^{mm} in diameter, soon naked, pulverulent. Teleutospores rather different in form and size, mostly elliptical to clavate, apex rounded, surmounted by a large hyaline papilla, lower cell with a similar papilla on the germ-pore beneath the septum, rounded at the base or somewhat narrowed toward it. Central constriction moderate. Epispore beset with minute warts, hardly visible in water, brown; $50–80 \times 21–34\mu$. Pedicels deciduous, usually short.

On *Caltha biflora.* Skamania co., Wash., Aug. 1888, leg. W. N. Suksdorf.

This is the fourth Puccinia on Caltha, all of which are said to occur in North America. *Puccinia Treleasiana* Pazschke on *C. leptosepala* and our species on C. biflora are exclusively American. *Puccinia Zopfii* Wint. and *P. Calthæ* Lk., both on *C. palustris*, have also a wide distribution in Europe. I have never seen the last named species from America. For comparison we give figures of all four species.—Plate XXIX, figs. 1–4.

Puccinia hyalomitra D. & H., n. sp.—Sori hypophyllous, oblong, $1–5^{mm}$ long, brown, pulverulent. Spores elliptical, slightly constricted at the septum, rounded at the base, apex with a flat conical hyaline thickening, lower cell provided with a similar lateral thickening, membrane thick ($5–6\mu$), chestnut brown, smooth, $47–53 \times 32–37\mu$. Pedicels colorless, easily detached at their bases with the spores, 100–120μ long.

On *Chrysopsis villosa.* Helena, Mont., April, 1889, leg. F. D. Kelsey.

Puccinia Chloridis mihi in Hedwigia **31:** 290, 1892, is apparently identical with the previously named *Puccinia Chloridis* Speg.

Phragmidium biloculare D. & H., n. sp.—Sori hypophyllous and on the pedicels and stems, on the leaves circular or oblong, often following the principal veins and confluent into long patches, soon naked, pulverulent. Uredosori orange yellow, teleutosori dark brown. Uredospores ovoid or elliptical, 22–30 × 15–23μ, membranes colorless with minute distant papillæ. Teleutospores usually two-celled, seldom three-celled, elliptical, blunt or rounded at both ends, barely constricted or not at all, membranes yellow brown or dirty brown, so transparent as to make recognizable the orange red contents, covered with large tubercles which swell somewhat in water, sometimes nearly smooth, provided with three germ-pores in each cell, 30–44 × 20–28μ, three-celled spores 45–54μ long. Pedicels colorless, to 60μ, detached with the spores.

On *Potentilla gelida.* Chiquash Mts., Skamania co., Wash. Aug. 1892, leg. W. N. Suksdorf (no. 351).

It will seem contradictory that we have placed this fungus in the genus Phragmidium, for the three-celled spores are present only in a very small number, about one per cent. But in many other respects it accords so completely with the typical Phragmidia, that, in placing it in the genus Puccinia, one would separate this species from its nearest allies. We shall discuss particularly this point on another occasion.

Tilletia Elymi D. & H., n. sp.—Spore masses black, destroying the ovaries. Spores globose, dark olive brown, 24–28μ in diameter. Epispore reticulated with ridges 2.6–4μ high and about 3μ apart.

On *Elymus* spec. Skamania co., Wash., Aug. 1886, leg. W. N. Suksdorf.

Tolyposporium Davidsonii D. & H., n. sp.—Spores produced in spherical firm walled galls of about 0.7^{mm} diameter, on the outside and at the bases of the perigonial leaves and the leaflets within the inflorescence. Spore mass powdery, light chocolate brown, discharged by irregular ruptures of the galls. Spores aggregated in very different manner into balls of 2 to 7 cells or isolated, longish or isodiametric, flattened on the sides of contact, pale, densely verrucose. Dimensions of the spore cells 12–15×7–13μ.

On *Atriplex* spec. Los Angeles, Calif., Sept. 1893, leg. Dr. A. Davidson. This is a very remarkable fungus on account of its peculiar appearance, represented in plate XXIX, fig. 5. The arrangement of the spore cells is a very variable one. In bicellular spores the cells touch each other by their longer sides, or the plane of separation is inclined (figs. *7a*, *7b*). In three-celled spores the cells are arranged into a triangle (*7c*) or into a straight line or in an intermediate manner (*7d*). If the spore ball is four-celled, the component cells are situated across in the same plane (*7e*), or may be arranged in a different manner (*7f*). Likewise in aggregates of more than four cells, these may lie in the same plane (*7g*) or form a nearly spherical body (*7h*). More than seven cells in one spore ball have not been observed; the most frequent cases are two to four cells. The spores are produced within small pisiform receptacles walled by a few layers of parenchymatous cells of the host plant. The formation of the spores begins in the center of the galls and gradually proceeds outwards. In the more advanced conditions the interior wall of the cavity is covered with a stratum of hyphæ whose innermost beds are transformed into a gelatinous mass forming the spores (see figs. 6 and 8).

Peronospora phlogina D. & H., n. sp.—Conidiophores erumpent in whitish afterwards dirty flocks from the under surfaces of the leaves, five to seven times bifurcated, the terminal branchlets slightly curved. Conidia ovoid, 26–29×16–20μ, nearly colorless, in masses appearing dirty brownish, smooth. Oospores spherical, 32–48μ diam., coarsely verrucose, yellow brown.

On *Phlox divaricata*. Decorah, Iowa, June 1888, leg. Holway.

Leipzig, Germany.

Explanation of Plate XXIX.

Fig. 1, Puccinia areolata.—Fig. 2, Puccinia Treleasiana.—Fig. 3, Puccinia Zopfii.—Fig. 4, Puccinia Calthæ. ×400.—Figs. 5–8, Tolyposporium Davidsonii.—Fig. 5, A diseased twig of Atriplex (with broken leaves) ×2.—Fig. 6, Part of a section through a gall. ×250.—Fig. 7, Spores. ×500.—Fig. 8, Young spores.

James Logan, an early contributor to the doctrine of sex in plants.

JOHN W. HARSHBERGER.

No part of botany has so often engaged the pen of the historian as the doctrine of sexuality in plants, established by Rudolph Jacob Camerarius in his works collected by Johann Mikan, professor of botany in Prague, under the title Opuscula Botanici Argumenti. Before the year 1691, and after that date although to a less extent, the authority of the ancients was still great, for in the books of that time, the views of Aristotle, Empedocles and Theophrastus are constantly quoted in support of one theory or another. Even Camerarius insists that the opinion of the Greek authors on natural history is not opposed to his sexual theory. A perusal of the works of Grew, Ray, and Malpighi show how loath these botanists were to set up their opinions against the scholasticism of the middle ages. A historical retrospect interestingly shows that progress in botany, as in every science, was made spasmodically, and often in an uncertain and indirect way did the leaders in botanical thought break away from the scientific mysticism of the ancients.

The path forward was a long and tortuous one. The philosophical speculations, founded deductively on the hypothetical observation of nature, could only be set aside and a true science created in one way, namely that of experiment. The value of Camerarius's work lies in the fact that he for the first time attempted to solve the question and remove the difficulties which embarrassed the sexual theory by direct experiment. To the scanty knowledge concerning the date palm, the terebinth and the 'malus medici,' as given by Theophrastus, and the untrustworthy observations of Ray and Malpighi, Camerarius added much of value by his careful investigations.

Sachs, in his "History of Botany," after a full discussion of the matter, giving all honor to the scientific spirit of Camerarius, names him as the founder of the doctrine of sexuality in plants, and states further, that the botanists Bradley, Logan, Miller, and Gleditsch, were instrumental in adding much additional experimental proof. The purpose of this paper is to show how far James Logan, an American and Philadelphian, contributed to lay the foundations of that doctrine which received its true scientific stamp from the hands of Joseph Kölreuter, Conrad Sprengel and Karl Friedrich Gärtner.

Philadelphia at the beginning of the eighteenth century stood for the excellence of science in America. Franklin, Bartram and Logan lived contemporaneously. It is to the little known writings of James Logan, an Irishman, governor of Pennsylvania, that I wish to advert. Sachs mentions him as one of the adherents and a founder of the sexual theory in plants, one of the first to determine by direct experiment the necessity of the pollen (farina) to the fecundation of the ova (ovules). The experiments were made to controvert the statements of M. Geoffroy in Miller's dictionary to the effect that by some experiments on maize, he (M. Geoffroy) was convinced that seeds may grow up to their full size and appear perfect to the eye without being impregnated by the farina (pollen). James Logan states in a letter to Peter Collinson, dated Philadelphia, Nov. 20, 1735, that he had reason to think otherwise.[1] His experiments were undertaken with a definite end in view, to test the truth of M. Geoffroy's statements.

The results of the experiments were given in brief in the letter to Peter Collinson, and later a full account was published in Latin in a work entitled, "Experimenta et Meletemata de Plantarum Generatione, etc., auctore Jacobo Logan, *Judice Supremo, & Praeside Concilii Provinciæ Pensilvaniensis in America.* Lugduni Batavorum. Apud Cornelium Haak 1739," pp. 3–13. (Preface dated Philadelphia 1737.)

Dr. Fothergill, the "J. F." of the English preface, translated the work of 1739 into English. The English version was published in London in 1747 under the title, "Experiments and Considerations on the Generations of Plants, translated from the Original Latin by J. F., London, printed for C. Davis, over against Gray's Inn Gate, Holborn, 1747." The Latin text appeared on one page, and opposite to it, on the other, the English translation. Sachs mentions both of these works, but was unable to consult them in the preparation of his history. Dr. Fothergill's preface to the English edition is worth quoting, as an introduction to Governor Logan's experiments.

[1]Phil. Trans., **34:** 192–195.

"The following essay in Latin was published at Leyden in 1739: It is now translated and reprinted here, that the sentiments contained in it may be submitted to more general consideration. Our author's address in choosing and conducting experiments, and his capacity for the abstrusest researches would doubtless have enabled him to have given to the world ample satisfaction on this intricate subject had he been permitted to prosecute his inquiries. But his country called him [Cincinnatus like] to more important affairs, and kept him constantly engaged in employments more immediately beneficial to society.

"The translator has endeavored to keep close to his author's sense. In point of expression, he fears, he often falls short of the original, the style whereof is nervous, concise and truly Roman. The Latin botanical terms are mostly retained, as we have not yet words in our own tongue to express the various parts of plants and flowers, which the growing science is obliged to describe, and to explain by terms adopted from other languages, etc. J. F."

The experiments, given in the quaint style of the period, speak for themselves.

"As several doubts had formerly occurred to me, in respect to the generation of both plants and animals, when I first heard of the *farina foecundans*, or impregnating male dust, I conceived great hopes that these would be easily solved, and the whole of this intricate affair receive considerable light from the discovery. And as I had long ago observed with surprize, the singular way of growth of our Indian wheat or maize, I judged it, of all plants I had seen, or perhaps of any that nature produces, the most proper one for experiments of this kind. Indian wheat grows to the height of six, eight and sometimes ten feet. At the top of the stalk, it bears a thready tuft or tassel (called by Malpighi muscarium), furnished with apices [anthers] which yield the farina. From the joints of the stalks below, the ears grow out, which are six, eight, ten and sometimes even twelve inches long. These consist of a pretty solid substance, about an inch thick, set quite around with grains regularly disposed in rows, in a very beautiful manner. Generally there are eight such rows, often ten, sometimes twelve, and I once saw sixteen. There are commonly forty grains in each row, more or less; which in their first rudiments, and whilst the stalk they grow upon is soft and tender may justly be called the ova or eggs. To each ovum, there adheres a white, fine, smooth filament, which excepting that it is hollow, resembles a thread of silk. These filaments are disposed, one by one, in order, betwixt the rows from that end where the ear rises from the stalk to the other, where they creep from under the base, that encloses the ear, and make their appearance, in the open air, in a bundle or skein. Their color in this part is mostly whitish, though sometimes a little yellow, red or purple, according to the nature of the plant they grow from. These filaments, as I formerly suspected are the real styles of the eggs.

"Intending, therefore, to make some experiments on this plant, towards the end of April, I planted four or five grains on hillocks, as is usual in sowing maize, in each corner of a little garden I had in town, which was forty feet wide and eighty feet long. About the beginning of August, when the plants were full grown, and the tufts on the top, and the ears on the stem had acquired their full extent, I cut off these tufts from every plant on one hillock. On another without meddling with the tufts, I gently opened the leaves that covered in the ears, and cut away from some all the styles and then closed the leaves again; from others a quarter part, from others one half, and from others three quarters, and left the rest untouched. I covered another ear, before the skein of styles appeared out of the case, with a piece of very fine, soft muslin, but so loosely, that its growth could not be injured, and whilst the fuzzy texture of the muslin suffered it to receive all the benefit of the sun, air and showers, the farina was effectually secluded. I left the plants on the fourth hillock, as I did these except in the circumstances above mentioned, unmolested till they were fully ripe.

About the beginning of October, when it was time to inquire into the success of my experiments, I made the following observations. In the first hillock, where I had cut off all the tufts, the ears whilst they remained covered with their husks, looked indeed very well, but were small, and felt light when handled; and not one perfect grain to be found in them, except in one large ear, which grew out somewhat farther from the stalk than usual, and on that side too which faced another hillock in a quarter from whence our strongest winds most commonly blow. In this ear alone, I found about twenty grains which were full grown and ripe. I attributed this to the farina brought by the wind from a distant plant. In those ears from which I plucked off some of the styles, I found just so many ripe grains as I had left styles untouched. In those covered with muslin, not one ripe grain was to be seen. The empty or barren eggs were nothing but mere dry husks.

"From these experiments, which I made with the utmost care and circumspection, as well as from those made by a great many other persons, it is very plain, that this farina emitted from the summits of the styles, is the true male seed, and absolutely necessary to render the uterus and grain fertile, a truth which however certain, yet was not known till the present age. The discoverer of this grand secret of nature ought ever to be remembered with due applause. Sir Thomas Millington, sometime Savilian professor, seems first to have taken notice of it, before or about the year 1676 [simply a conjecture without experimental proof] according to the account which Dr. Grew gave in a lecture read before the Royal Society the 9th of November the same year (see Grew's Works p. 161, 171). Malpighi nowhere that I know of, mentions its use. And Grew himself, though he allows it necessary for fecundation, yet did not suspect that it entered the uterus: but S. Morland about twenty years after, asserted that it entered the uterus through the canal of the style (see Phil. Trans. No. 287). I once saw a small grain in the middle of this canal; nor is it to be doubted, but that stricter inquiries will discover more of them passing the same way."

In another paragraph, Logan seems to presage the discovery of the fact that nature abhors continuous self-fertilization by providing many adaptive floral arrangements. He says: "Not only in this plant, in nut bearing trees, reeds, in all the tribe of gourds, as pompions, melons, cucumbers, etc., in which the male and female parts of generation are separately placed, but also in most of those flowers which from both parts being placed within the same flower-cup, are by some called hermaphrodites, the apices are so situated that after the farina is perfected, they can seldom, if ever, touch the summit of the style or os uteri. But in these, as well as in such where the organs are separately placed, the farina must of necessity, after it is thrown off from the apices, float in the circumambient air and be subject to the hazard of not reaching the os uteri, and performing its office there," etc.

Another observation of his is quite modern in its view: "There is likewise farther to be observed in the maize, that on the same day when the apices burst and hang loosely waving in the air, the skein or bundle of styles appear from under the husk or sheath that covers the ear, and are in like manner exposed. This circumstance should put us upon observing what happens in this respect to other plants."

It is certainly to be regretted that Governor Logan did not observe what happens in other plants, but gave his time and attention to state affairs, for much that Sprengel afterwards made known might have been unraveled by him. His experiments might pass for those of the present age, but unfortunately he did not confine himself to recording facts pure and simple, but in the latter part of his paper wandered off into disquisitions on the nature philosophy of his day. The following explanation of Logan's to account for the sexual process smacks of medieval scholasticism.

He states boldly, that his observations are in support of the doctrine of sexes in plants, and that "there is room to apprehend that this [Logan's] hypothesis concerning generation will be readily adopted by posterity." "The farina is committed to the air, that it may receive out of the air, the little seed or plant, pre-existent and completely formed, tho' in stamina inconceivably minute and invisible; and thus becomes pregnant thereby." "It is drawn by an inherent attractive force first into the style, and through that it slides by proper canals to the ova, and from this farina, nourished by the juices of the plant for the purposes above described, the bulk of the seed is formed. Lastly the little plant hid in the seed and clothed with a terrestrial matter, which it borrows from the farina, exerts itself, and, increasing by proper nutriment, which it draws from the earth, at length springs up."

One is reminded of the theory of evolution of Claude Perrault and of his "aura coelestis" of the opinions of Wollaston and Varro. Logan, although he had worked at the matter experimentally was unable altogether to throw off the shackles of scholasticism. So much is a man influenced by the age and time in which he lives. Nevertheless, Governor Logan deserves more than a passing mention in any future discussion of the sexual theory of plants.

University of Pennsylvania, Philadelphia.

A preliminary synopsis of the North American species of Amaranthus.

EDWIN B. ULINE AND WILLIAM L. BRAY.

(*Concluded from p. 272.*)

§2. *Sepals 5, oblong with mucronate tip, or acute, pungent pointed, not conspicuously nerved, mostly unequal (the outer one long and spiny pointed), thin or somewhat thickened at the base, not urceolate: utricle thin, scarious and little wrinkled or retracted after dehiscence: leaves mostly large and long petioled: flowers in naked terminal or axillary mostly panicled spikes (*EUAMARANTHUS).

The species of this section are with difficulty distinguished.

* *Stamens only 3.*

Forms related to those of § 1, but with nearer relationship to typical Euamaranthus.

12. A. POWELLII Watson. Proc. Amer. Acad. **10**: 347. 1875.

The three species of Watson, viz: *A. Powellii, A. Wrightii,* Proc. Amer. Acad. **12**: 275. 1877 and *A. obovatus,* l. c., together with certain Arizona and Oregon specimens constitute the species as re-defined. The group of forms thus united stand midway between the AMBLOGYNE and EUAMARANTHUS sections. On plant habit and inflorescence it would be impossible to separate these satisfactorily from the remaining Euamaranthus species, but in all the plants of this species that we were able to examine, no exception occurs to the three stamen character, while out of ten plants each of *A. retroflexus* and *A. hybridus* carefully examined, scarcely a reliable exception to the five stamen character was found.

* * *Stamens 5.*

Includes a maze of indistinguishable forms comprising some of the coarsest and rankest weeds. Of the several species previously enumerated, but two are retained.

13. A. RETROFLEXUS L. Sp. Pl. Ed. II. 1407. 1762.

Spreading everywhere throughout the United States as a coarse rank week, sometimes growing eight to ten feet high. Apparently indigenous southwestward where it may be satisfactorily distinguished from *A. hybridus* by its strict spikes, oblong sepals, green color and pubescence.

14. A. HYBRIDUS L. Sp. Pl. 990. 1753.

A. hypochondriacus L. Sp. Pl. 991. 1753.

A. Chlorostachys Willd. Hist. Amarant. 34. *pl. 10. f. 19.* 1790.

A. Chlorostachys var. *hybridus* Wats. Gray's Man. Ed. 6. 428. 1889.

This species is scarcely less widespread than the preceding, also indigenous southwestward, both species having rapidly spread northward from tropical America. Typical specimens reported from Mexico are distinguished from *A. retroflexus* by the longer drooping spikes, acute unequal sepals and mostly brown scarcely pubescent stem. In their spreading northeastward these two species overlap so much in characters that frequently no distinction can be made. The name *hybridus* is given preference by reason of its sequence in the Linnæan order of presentation.

Var. PANICULATUS Uline and Bray, Mem. Torr. Bot. Club, **5**: 145. 1894.

Not sufficiently distinct from the species, but provisionally embraces those forms having reddish color and lanceolate leaves, and particularly those with very long, slender, flexuous, paniculate spikes and commonly shorter bracts.

15. A. CAUDATUS L. Spec. Pl. 990. 1753.

A. leucospermus Wats. Proc. Amer. Acad. **10**: 347. 1875.

Resembling *A. hybridus*, but easily recognized by the white or yellowish seed with rimmed margin (marking the albumen line). Originally from the American tropics but spreading northward in Arizona where the Indians cultivate it for the seed.

* * * *Stamens irregularly 3 to 5: bracts very long and acuminate.*

16. **A. bracteosa,** n. sp.

Plant erect or ascending, glaucous: leaves distant, fleshy, long-petioled, spatulate-obtuse: glomerules interrupted, axillary and terminal: bracts foliaceous, awl-shaped, 6 to 10^{mm} long (thrice the length of the calyx).—New Mexico (*A. Fendler* 735 in 1847.)

This specimen is in the Gray Herbarium and is labelled *A. retroflexus*, though it is radically distinct from that species as it is from all other Euamaranthi in its thick glaucous spatulate leaves and the remarkably long leafy bracts. Another specimen in the National Herbarium was raised from Arizona seed by Dr. Vasey in 1876. Its locality in Arizona is not known.

§ 3. *Sepals 5: utricle thin, bursting or imperfectly circumscissile: a pair of stipular spines in the axils of the large leaves.*

17. A. SPINOSUS L. Sp. Pl. 991. 1753.

Known as the only thorny amaranth. A slovenly weed, spreading from South America northward through Mexico and the West Indies, throughout southern and southeastern United States north to Kansas and New England.

§ 4. *Sepals various: flowers in very small axillary spikes or clusters: stem low or prostrate with smaller leaves than in the preceding sections: stamens 3.*

* *Sepals of both kinds of flowers 4 or 5: plant prostrate: utricle circumscissile: seeds large* (1.3^{mm}).

18. A. BLITOIDES Wats. Proc. Amer. Acad. **12:** 273. 1877.

Indigenous westward; first described from Nevada specimens. In recent years it has spread eastward over all the temperate portion of the United States to the Atlantic coast, occurring most abundantly in the vicinity of the larger thoroughfares. *A. blitoides* has heretofore been classified with the Pyxidium group, the error being due to a mistaken conception of the number of fruiting sepals. Watson assigns three sepals to it, though it is difficult to see how he could have committed the error, for the very types upon which he founded the species clearly contain four or five sepals in addition to the subtending bract.

Var. **densifolius,** n. var.

Leaves exceedingly crowded, small, oblanceolate (1 to 2^{cm} long).—Arizona, Hackberry (*Rusby* 804); Colorado (*Greene* 614).

Var. **Reverchoni,** n. var.

Stem and branches very slender: leaves narrow, reduced, not crowded: calyptra of utricle brownish red.—Collected near Dallas, Tex., in 1881 (*Reverchon*, 824).

The character of red coloration in the utricles is not exclusive, but was also seen in specimens of *A. blitoides* from Providence, R. I., and Scott's Bluff co., Neb.

* * *Sepals four or five, spatulate, united at base: peduncles and pedicels (apparently abnormally) thickened* (SCLEROPUS.)

+ *Utricle indehiscent, thick, coriaceous: style branches 2, lyrate in fruit.*

19. A. CRASSIPES Schlecht. Linnæa, **6:** 757. 1831.

Geographical range the same as *A. polygonoides* with which it has been included (Hemsley Biol. Cent. Am. **3:** 14) on the supposition that the incrassate character of the peduncles is pathological. This plant would not fall with *A. polygonoides* even if this were true, because of more widely differing characters. Mr. Holzinger's investigations (BOT. GAZ. 17: 254. 1892) seem to show that the incrassations are not pathogenic, but normal. In any case the phenomenon is constant in geographical limits and suffices in itself for a reasonably stable diagnostic character.

+ + *Utricle circumscissile, smooth: style branches* 3.

20. **A. scleropoides,** n. sp.

Stem whitish, slender, erect (3^{dm} high) with few erect branches: leaves small (1 to 1.5^{cm}), oblanceolate: peduncles and pedicels indurated: sepals five, unequal, spatulate, one-nerved, united at base: utricle smooth, circumscissile, equalling the calyx: stigmas two or three, divaricate at maturity: seed obovate, 0.6^{mm} in diameter.—Near El Paso, Texas (*Wright* 582 *in part*).

Quite distinct from *A. crassipes* in habit, character of seed, utricle and stigmas. It may be regarded as intermediate between *A. crassipes* and the Pyxidium section, approaching the latter by reason of its dehiscent utricle and three stigmas. From *A. græcizans,* its nearest relative, it is distinguished by its obovate seed, shorter stigmas, smooth utricle, short bracts and indurated peduncles.

* * * *Sepals thin, inconspicuous,* 3 *or fewer.*

+ *Sepals 3.*

++ *Bracts conspicuous, long, pungent: seed small* (0.6^{mm} *wide*).

= *Plant erect.*

21. A. GRÆCIZANS L.[1] Sp. Pl. 990. 1753.

A. albus L. Syst. Ed. X. 1268.

A. albus Willd. Hist. Amarant. *pl. 4. fig. 7.*

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[1] Of the Pyxidium group as defined by Moquin-Tandon, the following have been referred to North America: *A. blitoides* Wats., *A. albus* L., *A. græcizans* L. (*A. Blitum* var. *græcizans* Moq.), and *A. Blitum* L. *A. blitoides* is easily told by its four or five sepals, thick at base, and by the prostrate habit. But great confusion prevails in the remaining forms. *A. albus* was said by Linnæus (S. X. 1268) to have come from Pennsylvania while A. *græcizans* (Sp. I. 990) was ascribed to Virginia. But there is only one set of forms in our eastern states that can approximate any correspondence to the descriptions, namely, that one long known as *A. albus* L. Linnæus (Mant. II.) declared them to be too nearly related, while Willdenow unquestionably figures our plant under the name of *græcizans* (Hist. Amarant. *pl. 4. fig. 7*). Moreover, specimen 1931 *Hartweg* from California, which Moquin calls *A. Blitum* var. *græcizans* (*A. græcizans* L.) is *A. albus* L. and was so named on the sheet in Sereno Watson's handwriting. *A. græcizans* and *A. albus,* then, are identical, and the older name is retained. This arrangement also eliminates *A. Blitum* from the North American flora.

One of the so-called "tumble weeds," found everywhere from Arctic North America to Mexico. It is very variable in habit, assuming the spherical tumble weed shape in the upper Mississippi valley and on the western plains. Known from its habit and particularly from the numerous long pungent bracts. Certain upright forms with larger leaves and tardily dehiscent utricle resemble the erect *A. Californicus*, but the presence of long bracts points to *A. græcizans.*

Var. **pubescens,** n. var.

Diffuse, spreading from a common root-stock, covered with dense viscid pubescence, which at length causes the plant to be covered with sand and dust: leaves very much crisped: bracts broader and shorter, not so sharply pungent: sepals thicker and longer than in the species.—New Mexico and Arizona.

Specimens examined: New Mexico, Silver City (*Greene* 185 in 1880), Empire City (*Torrey* 457 in 1865), Camp Bache (*Bigelow* in 1852), place unknown, (*Fendler* 731 in 1847); Arizona, Flagstaff (*Jones* 3978 in 1884), San Francisco Mts. (*Knowlton* 198 in 1879).

= = *Plant prostrate.*

22. A. CARNEUS Greene. Pitt. **2**: 105. 1890.

Prostrate, branches somewhat radiate, slender, pinkish, the glomerules and lower face of the leaves purple: plant floriferous throughout: leaves setose-tipped, 1.5 to 2.5^{mm} long: bracts acuminate, setose-tipped (shorter than those of A. græcizans): utricle smooth, seed 0.6^{mm} wide.—Montana, Idaho and Oregon.

This species is too near *A. græcizans* in leaf, bract, floral, and seed characters; but in its depressed habit and an occasional reduction of sepals either in number or size, it seems to be working out certain characters of *A. albomarginatus.*

++ ++ *Bracts not conspicuous: seeds larger.*

23. A. BLITUM L. Sp. Pl. 990. 1753.

See footnote under *A. græcizans*, p. 316.

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for the plants referred to in Man. 6th. ed. from New York city and Boston under that name prove to be either *A. blitoides* or *A. lividus*. It also serves to distinguish *A. græcizans* L. and *A. sylvestris* Desf. which are reduced to one under the name *græcizans* in the Kew Index. The latter stands as Moquin's idea of typical *Blitum* (*A. Blitum α sylvestris* Prodr. **13**^{2}: 263), which he says was recognized by Planchon as identical with Linnæus' type in herb. Adding to this Willdenow's suggestion that perhaps *A. græcizans* was not eastern at all, *A. Blitum* must be taken as the abundant Continental and oriental form, a view which is repeatedly substantiated by the labels on the old specimens in the Bernhardi herbarium.

+ + *Sepals fewer than* 3. (MENGEA).

24. A. CALIFORNICUS Wats. Bot. Calif. **2:** 42, 1880.
Mengea Californica Moq. DC. Prodr. **13**[2]: 270. 1849.

Diffuse ascending or erect: leaves spatulate or ovate varying from 0.5 to 3.5^{cm} long on the same plant, only the uppermost white-margined. Flowers not differing essentially from the following.—California, from San Diego to Mendocino county, and western Nevada.

25. **A. albomarginatus,** n. sp.

A very dense-leaved prostrate plant forming a dense mat on the ground. Stem white, leaves elliptical, uniformly very small (the smallest known in the genus, averaging only about 3 to 4^{mm} in length), all conspicuously white-margined: flowers crowded amongst the dense foliage, sepals reduced to 2 or 3 minute scales, mostly appearing only one-sepaled.—Monterey co., California (*Palmer* 456 in 1876). Distributed as *A. Californicus.*

§ 5. *Sepals two to five, narrowly oblong or spatulate, widely separated, mostly longer than the indehiscent utricle: bracts inconspicuous.*

Six species of this section are found in the United States. It is interesting to note that all of these occupy about the same relation to our flora in being adventive, or but recently introduced from other countries. Thus, excepting that *A. crispus* is found at Albany, N. Y., *A. emarginatus* Salzm. only at New Orleans, and *A. deflexus* "in gardens about San Francisco Bay" (*Greene*), all are confined to the coast belt between Boston and Key West. Their presence may be attributed to introduction through shipping, except in the case of *A. viridis* L. which is especially interesting. We have examined plants of this species, which show no notable variation, from Paraguay, Brazil, British Guiana, West Indies, Mexico, New Orleans, southern Florida, North Carolina and New Jersey. (In the last two places on ballast ground.) This indicates a path of progress northward from its indigenous region "where it is the common pig-weed" (Morong, on labels of specimens from Paraguay).

* *Stem erect, succulent, mostly deep red or purple: leaves large.*

+ *Utricle smooth, scarious.*

26. A. LIVIDUS Linn. Sp. Pl. 990. 1753.

Further distinguished from the next by its larger, more emarginate leaves, fleshier stem, inflorescence more glomerulate, with a short rather thick terminal spike.—Found about Boston and New York city.

+ + *Utricle rugose, coriaceous.*

27. A. VIRIDIS L.[2] Sp. Pl. Ed. II. 1405. 1762.

Leaves rather smaller and more acute than in the preceding: inflorescence in slender flexuous spikes, the terminal longest, with several shorter ones crowded near its base.

Stem weak, flexuous, prostrate: leaves small.

+ *Utricle smooth, leaves deeply emarginate.*

28. A. EMARGINATUS Salzm. ex Moq. l. c. 274.

Euxolus viridis var. *polygonoides* Moq. DC. Prodr. **13**[2]: 274. 1849.
A. viridis. Index Kewensis **I**: 100. 1893.

Stem long and very weak, prostrate: leaves small, 1 to 2^{cm} long (not including petiole), 0.5 to 1.5^{cm} wide, rhombic-ovate, deeply emarginate, on long slender petioles which are about twice the length of the blade: inflorescence in small axillary clusters and very slender terminal spikes: bracts and sepals inconspicuous: utricle thin and smooth.—Probably South America.

Specimens examined: LOUISIANA, "Streets of New Orleans near river port, perhaps adventive" (*Langlois* no. 58. 1884). TEXAS, Matagorda Bay (*J. W. Robbins*, 1868).

This species stands near to *A. lividus* and *A. viridis*, having the smooth scarious utricle of the one and the inflorescence of the other. But the very slender whitish stem and small leaves make it rather more distinct from those than they are from each other.

+ + *Utricle rugose: sepals 5: leaves crisped.*

29. A. CRISPUS Braun. Gray's Manual 6th Ed. 428.

Native habitat unknown. For many years reported from Albany, N. Y.; also from "streets and uptown waste places" New York city and Brooklyn. We have seen specimens from the botanical gardens of Berlin and Harvard University.

+ + + *Utricle fleshy, prominently 3 to 5-nerved, much exceeding the 2 or 3 sepals.*

30. A. DEFLEXUS L. Mant. 2: 295. 1767.

Easily distinguished from *A. crispus* by the above characters and the larger oblong seed, and short thick terminal spikes.

Native habitat said to be southern Europe. It is reported from

[2] The names *lividus* and *viridis* have both been used to designate each of these two forms; some authors calling the smooth utricled form *A. viridis* and rugose one *A. lividus*, while others have done just the reverse. We have here decided to use the names as indicated on specimens compared by Dr. N. L. Britton at Kew.

Valparaiso, Chile, and recently from the San Francisco Bay region. All the specimens seen from the United States were from ballast soil. Now well established about New York city. (*Addison Brown*, 1880.)

* * * *Stem short, fleshy.*

31. A. PUMILUS Raf. Med. Repos. **5:** 360. 1808.

Found on the Atlantic coast from Rhode Island to North Carolina. Leaves fleshy rhombic-ovate to ovate, sometimes almost orbicular.

This species has the largest seed of any member of the genus known to us, and also departs farther from the generic type than any other species.

32. **A. acutilobus** (A. Br. & Bouché), nom. nov.

Euxolus emarginatus A. Br. & Bouché Ind. Sem. Hort. Berol. 1851, not Salzm. ex Moq.

A. viridis Index Kewensis **1:** 937, in part.

Habit of *A. emarginatus:* the leaves narrower and more retuse, almost obcordate with acute lobes: inflorescence axillary, crowded toward the tips of the branches in a loose leafy spike: bracts very conspicuous, setose, at least twice the length of the utricle, in this respect differing radically from all of the *Euxolus* section.

Two of the sheets examined bear the signature of A. Braun, dated 1851 and 1857, at which times were issues of "Indices Seminum" of the Berlin Bot. Garden by A. Braun and Bouché. We saw one specimen from the Bot. Gard. Harvard University 187- and also one from Mo. Bot. Gard. Herb. with place of cultivation not mentioned. All the others were raised from Mexican seed.

Herbarium Lake Forest University, Lake Forest, Ill.

Crystals of ice on plants.

J. CHRISTIAN BAY.

That ice crystals are formed on the surface of plants under certain conditions of weather and surroundings, as has been noticed lately by Profs. L. F. Ward and D. T. MacDougal, is by no means little noticed. In the winter and spring of 1892 and 1893, these crystals were not unfrequent in Tower Grove Park and the adjacent fields in St. Louis, and I observed this phenomenon also in Europe, in the Botanic Garden, Copenhagen, as far as I remember, in the winter of 1887–88.

Supposing that the phenomenon has been sufficiently outlined by the two first named observers[1], I add the following references to those named by MacDougal.[2]

James D. Dana mentions[3] that he has found, on cold mornings in spring and autumn, thread-like ice-crystals appended vertically to the stems of trees. Papers concerning the same subject are:

R. CASPARY, Auffallende Eisbildungen auf Pflanzen. Botan. Zeitung **12:** 665. 1854. H. HOFFMANN, Pflanzenklimatologie 329. 1857. HUGO VON MOHL, Botan. Zeitung **18:** 15, 16. 1860. J. SACHS, Krystallbildungen bei dem Gefrieren. Berichte d. kgl. Sächs. Akad. d. Wiss. zu Leipzig. Math.-phys. Cl.—:1. 1860. C. NÆGELI, Ueber die Wirkungen des Frostes auf die Pflanzenzellen. Sitzungsber. d. Münchener-Acad. d. Wiss. Math.-phys. Cl., 9 Februar, 1861.

The communication of Sachs is, of course, classical. It should be remembered that H. de Vries and H. Müller-Thurgau have also been working with the influence of cold upon plant cells; likewise Goeppert.

a. Plants on which ice-crystals have been observed.

Conyza bifrons L. (Pluchea bifrons DC.) [S. Elliott, 1824.] Marsh Fleabane
Carduus sp. [Herschel, 1833.]
Heliotropium sp. [Herschel, 1833.]; H. peruvianum (Bouché and Caspary, 1854.)

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[1] See BOT. GAZ. **18:** 183. 1893.—Science—: 351. 29 D 1893.
[2] Cf. also Quarterly Bull., Univ. of Minn. **2:** 30–31.
[3] Manual of Mineralogy, 46. Ed. 2, New Haven and Philad., 1849.

Cunila Mariana [Darlington, 1837; John Le Conte, 1850; L. F. Ward, 1893; MacDougal, 1893; Atkinson, 1885–6. (see BOT. GAZ. **19:** 40–42. 1894.)]

Pulchea camphorata DC. [John Le Conte, 1850.]

Helianthemum Canadense [Eaton and Bigelow; publ. 1837 by Darlington.]

Lantana aculeata, Tagetes Bonariensis, Perilla arguta, Alonsoa incisifolia, Cuphea cordata, C. tubiflora, C. platycentra, Manulea oppositifolia, Calceolaria perfoliata [Bouché and Caspary, 1854.]

Viburnum Tinus [Hoffmann, 1857.] (?) Vernonia sp. [Atkinson, 1885-6.]

Aucuba sp. [Hoffmann, 1857].

Gymnocladus sp., Ailanthus sp., Juglans sp., Asimina triloba, Paulownia; leaves. [von Mohl, 1860.]

Rhamnus sp., Amygdalus communis [Bay and Jensen, in scheda, 1887-88.]

The splitting of wood and the appearance of ice-crystals in the fissures are well known phenomena to tree-planters. In twenty-seven plants, the crystals have been hitherto observed; only those who do not possess sufficient knowledge of the literature will believe that a re-discovery has been made.

The occurrence of similar ice-crystals on the ground is well known in Germany where the crystals are called "Kammeis" (comb-ice); it has been investigated by J. Le Conte, von Mohl, Sachs, Hoffmann, and Caspary.

The many observations on sections of plants, made by Sachs, Nägeli, H. de Vries (Botan. Zeitung **37:** 649. 1879), and by H. Müller-Thurgau (Landw. Jahrb. **9:**) should be mentioned in this connection, only because they afford an opportunity of forming an opinion of the causes of these phenomena.[4]

b. Forms of the crystals.

1. Single ice-columns on the surface [Elliott, Hoffmann, Sachs, Bouché and Caspary]; id. on the surface of root-sections of *Beta* [Sachs; see also Bonnet, Usage des feuilles, p. LXXXII. 1754.]

2. Ice-threads united in sheet crystals [Herschel, Dana, Le Conte, Bouché and Caspary, Ward, MacDougal, Bay and Jensen].

3. Crystals of ice united and forming a layer on the surface; (*a*) under the bark of dead trunks, [Herschel], (*b*) of living trunks [Caspary], (*c*) on the fresh surface of the leaf-pulvinus of falling leaves [von Mohl], (*d*) on the surface of sections [Sachs, Nägeli, de Vries, Müller-Thurgau.]

In consequence of this, MacDougal's results one and two (l. c., p. 351) are premature, and cannot be maintained, since they do not represent all of the observations hitherto made.

[4]On the temperature of perennial plants in winter see Russell, BOT. GAZ. **14:** 216–222. 1889, and J. Le Conte, Am. Jour. Sci. II. **13:** 84–92, 195–206. 1852.

c. Formation of crystals.

1. The form and fabric of the crystals indicate that the latter grow, and that they are somatropic. The end of the crystals were first formed, and as the column grew, the primary ice-layers were pushed out into the places where they are afterwards found.

2. The central parts of the water-supply layers do not freeze.

3. The formation of the crystals does not result from the organic nature of the substratum; it depends entirely upon molecular forces.

That capillary forces are active in carrying water from the ground up to where the crystals are formed may be seen *a priori*; but the capillary forces *alone* cannot explain the phenomena here mentioned; the question is much more complicated. The contraction of the cells is one important factor, and the permeability of the membrane is another.

Von Mohl's explanation of the appearance of ice-crystals is "that the cold, before it pervades the branches, first causes a contraction in the outer layers, by this contraction the fluids are driven out into the already formed fissure, and there it freezes." That contraction of the layers in the lower parts of the stem of Cerasus does take place, I observed in the following way. The lower parts of the stem, measuring 10^{cm} in length, and about 4^{cm} in diameter was cut off from the rest of the young tree, and kept for three days at a temperature of 18° C. On the fourth day this piece, which had been hitherto kept in wet rags, was dried and placed outside the window where the temperature measured $-5°$ C. After a while big drops of fluid were observed on the cut surface of both ends, covering the entire surface; this fluid rapidly froze, and formed, in five hours, a layer of ice in the place where it had been forced out. A similar experiment was made by von Mohl on Rhamnus. (Cf. Sachs, l. c., 14). The ice-column at the ends of the stem were of a slight white color; they contained a great number of minute air-bubbles.

While Atkinson thinks "that there is a degree of root activity which furnishes the necessary water," and that "a specific variation in the root activity of different plants as related to different temperatures" is a factor in the development of the crystals, Mac Dougal is of the opinion that capillary forces are the only active agents. In regard to the first opinion, it is no doubt remembered that Sachs viewed the matter thus: "Jede Kraft, welche sehr langsam und continuirlich ein Austreten des Wassers im Sinne der Imbibition bewirkt, kann die Krystallbildung befördern, solche Kräfte sind die Contraction des Gewebes, der von den Wurzeln aus stattfindende Saftdruck." The older experiments of Sachs, as well as the latest investigations of Strasburger and especially of Schwendener[5] show that we know very little of the means by which water ascends to the middle and the higher parts of trees. Yet sheet-crystals are found at a considerable distance from the bases of the stems. As to the specific variations surmised by Atkinson, no record of experiments concerning them can be found in my lists of literature.

Capillary forces alone would hardly be able to supply the crystals, especially those on branches of trees, etc.; the old experiments by Montgolfier and Jamin, and the numerous later experiments with Jamin's chain prove this. It is well known that in capillary spaces filled with air and water, the latter does not move to any great extent.

For these reasons, and from the above mentioned freezing experiment, it becomes evident that the exudation of water from cut surfaces is in the first place caused by the contraction of the cells and tissues; we further know that cold produces a power of filtration in the membranes greater than under normal conditions of temperature. In cold, only a very slight pressure will be necessary to make the fluid appear at the ends of the wood. As far back as 1859, this was proved by Sachs (l. c., 39).

We have seen that the sheet-crystals are not only formed in the basal part of the stem, but that they are also found on branches of trees. Assuming root-pressure as one of the water-supplying agencies, we consider it quite remarkable that this should not be active in some cases; in other cases, however, no root-pressure can, for obvious reasons, occur.

Schwendener's investigations point towards "Triebkräfte besonderer Art" in the stem, and, as the specific nature of these forces is unknown, it is most safe to say that any agency which is able to force water upwards through the stem can supply the ice-crystals with water.

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[5]Sitzungsberichte der Akademie der Wissenschaften zu Berlin —: 561, 1886, and ibid, October 26, 1893.—I may add that it is four years since I saw Le Conte's paper; at present I have access only to the review in the "Annals of Scientific Discovery," ed. by D. A. Wells, Boston 1851, p. 157–160.

d. Conditions of formation of crystals.

From what has been said it appears that the conditions for the formation of the ice-crystals are:

1. The temperature must be above zero in the soil surrounding the roots of the plant [Le Conte and Sachs].

2. The temperature of the central parts of the water-conducting tissues must be above zero.

3. The soil must be sufficiently charged with water.

Summary.

The cold causes a contraction of the tissues all over the plant, and consequently the turgescence is very much diminished, as well as the permeability of the cell-walls to water. As the contents of the peripheral ends of the medullary rays freeze, expand, and are pressed forward, the stem splits in the place where it affords the least resistance, and the ice forms a layer covering the whole surface of the wound. The pressure from inside supplies water, the latter being drawn up by capillary forces.

Assuming that the freezing of the water in the ends of the medullary rays was, alone, the cause of the splitting of the stem, this explanation would be insufficient to explain the whole process, for, in many plants, the freezing does not cause the splitting and subsequent exudation from the cells.

It has been proved (Sachs, Müller-Thurgau, De Vries) that the coefficient of contraction is different in the different tissues, and it may be assumed that different plants (even different individuals of the same species or different parts of the same plant) have a different coefficient. MacDougal supposes that plants with large and numerous vessels and thin-walled cells in the medullary rays are especially adapted to form sheet-crystals. It is quite sure that such plants have a larger coefficient of contraction than other plants.

Capitol, Des Moines, Iowa.

[Since the above article was written, I have found a quite interesting note entitled "Frost, and the Cunila Mariana L., or dittany," by J. Stauffer, Mount Joy, Penn'a, in The Horticulturist and Journal of Rural Art, 7: 73–74. New York, 1857. On December 6, 1856, Mr. S. was passing near the Willistown Baptist Meeting House, in Chester co., Pa. Here, he found the ice crystals: "What, however, amply recompensed me for the attention bestowed, was the discovery that this plant is peculiar, and is truly a *frost plant* far exceeding the *Helianthemum Canadense*, or frost weed, as it is popularly called, from the fact that, late in autumn, crystals of ice shoot from the cracked bark at the root. Our *Cunila* has attached to the stem a shell-work of ice, of a pearly whiteness, beautifully striated, sometimes, like a series of shells one in another—at others curved round on either side of them like an open, polished, bi-valve; then, in others, again, curled over in every variety of form, like the petals of a tulip. No other herb or grass had any such frost-work around them; while at least fifty specimens of the *Cunila* were so ornamented. The root manifested a vigorous young bud underground."—BAY.]

Noteworthy anatomical and physiological researches.

Nourishment of the embryo and importance of the endosperm in viviparous mangrove plants.

The remarkable phenomena attending the germination of viviparous plants in the Rhizophoreæ and other mangrove plants have been noticed by a number of investigators. In the present paper[1] Haberlandt makes a noteworthy contribution to the knowledge of the subject.

Treub[2] was the first to call attention to the peculiar behavior of the endosperm in the Verbenaceous *Avicennia officinalis* which, with its included embryo, grows out of the micropyle into the cavity of the fruit while the latter is still attached to the tree. Later the placenta pushes out into the fruit in all directions, the endosperm serving as a haustorium to secure the necessary food for the embryo.

Warming[3] observed a similar outgrowth of the endosperm in *Rhizophora Mangle*. He describes it as a large celled clear tissue apparently entirely wanting in food material and extending above the ovule as a micropylar arillus, whose office seemed to be to conduct nourishment from the mother plant to the embryo. However he brought no certain proof to support this view. In this plant, according to Warming, the entire surface of the upper part of the cotyledon is thickly covered with glandular hairs, below which lie scattered secretory or haustorial cells which he calls true sessile glandular hairs.

Goebel[4] described vivipary in certain mangrove plants and also touched upon the haustorial nature of their endosperm. He states that the embryo in the rhizophorous *Bruguiera gymnorhiza* takes part of its nourishment from the cotyledons but that a large portion of the starch of the hypocotyl arises from its own assimilative activity, since a considerable amount of chlorophyll is found in its external tissues. Goebel also

[1] G. Haberlandt, Ueber die Ernährung der Keimlinge und die Bedeutung des Endosperms bei viviparen Mangrovepflanzen. Annales d. Jardin botanique d. Buitenzorg. **12**: 91–114. 1894. *pl. 10–12.* Leide: E. J. Brill.

[2] Notes sur l'embryon, le sac embryonnaire et l'ovule. Ann. d. Jardin bot d. Buitenzorg. **3**: 79 ff.

[3] Tropische Fragmente, II. Engler's Jahrb. **4**: 517 ff. 1883.

[4] Pflanzenbiologische Schilderungen, **1**: 113 ff. 1889.

maintains that the endosperm in this plant is consumed by the cotyledons. In the case of *Rhizophora conjugata* the same author considers that the endosperm, by means of the marked lateral growth of its upper portion, possesses the mechanical function of opening widely the micropyle, and thus serves to lead the way for the developing embryo or "cotyledonar bodies" whose upper surface is composed of a richly absorbing plasma tissue.

A. F. W. Schimper[5] has also furnished a valuable contribution to the literature of vivipary in the mangroves, especially in the myrsinaceous *Ægiceras majus* and in *Bruguiera caryophylloides*. In the latter the cells of the testa, rich in plasma, are provided with large nuclei and secrete a ferment. True assimilative activity in this case is greatly hindered by the want of stomata and by the thick cuticle. In *Rhizophora mucronata* the cone-shaped endosperm emerges from the micropyle and is soon perforated by the rapidly growing hypocotyl. The cotyledon is divided into three parts; the upper conical end represents a haustorium and its surface possesses a glandular structure similar to that of the cotyledons of Bruguiera. The central portion is expanded and prevents the heavy embryo from slipping down, while the petiolar basal part, which projects from the pericarp like a collar or crown, serves as a protective sheath for the plumule.

Finally, G. Karsten[6] has made very serviceable studies of the germination of the mangroves.

Haberlandt's observations have been confined principally to three species: *Bruguiera eriopetala*, *Rhizophora mucronata* and *Ægiceras majus*. In the young fruit of the first species can be seen solitary semi-lenticular endosperm cells, rich in plasma, which lie between the cotyledons and seed covering. These are the remains of the primary endosperm. Similar cells are also found in the endospermous slime which fills up the canal resulting from the juxtaposition of the cotyledons. Sometimes a roundish cluster of cells separated by their septa occurs. From the widely open micropyle projects a true endosperm tissue in the form of a collar or arillus, 2-4mm in width. This, however, is not reflexed as is usually the case in this genus and does not surround the embryo, but is intercalated between the calyx and the uppermost part of

[5]Die indomalayische Strandflora, 42 ff. Jena 1891.
[6]Ueber die Mangrove-Vegetation im Malayischen Archipel. Bibliotheca Botanica 22:—1891.

the hypocotyl. To the function of this organ we shall recur soon.

The importance of the above-mentioned semi-lenticular cells has been entirely overlooked by previous writers. According to Haberlandt they serve as starting points for the development of a many layered secondary endosperm which forms the haustoria already mentioned. This secondary endosperm sends between the loose parenchyma cells of the seed coat haustoria-like processes of one to many cells. These haustoria are frequently lobed and possess papillose ends. Their walls are of thick cellulose excepting those of the terminal cells which are thin.

The author sketches the development of this peculiar structure, which finally forms a flattish disk whose cells are easily distinguished from the surrounding parenchymatous tissue by their thickened walls and abundant content of protoplasm. The primary endosperm at this time has become reduced to a few cells. If now the sides of the cotyledons lying next to the testa are examined, their cells will be seen to be arranged radially, with the outer layer colorless and characterized by an abundance of plasma and large nuclei. In this stage of development the cotyledons act only as absorptive organs.

Haberlandt removed the cotyledonary bodies, which at this period are about as large as peas, carefully washed them and gave them a coating of wheat starch. Microscopic examination after twenty-four hours showed that the grains of starch were strongly corroded, thereby confirming the previous supposition of Schimper that the cotyledonary tissue secretes a diastatic ferment. The same corrosion was exhibited by the layer of secondary endosperm. Upon making cross sections through the integument and the endosperm the interesting fact was brought out that in many places solitary endosperm cells send in tube-like processes between the palisade tissue of the cotyledons, often to a depth of two or three layers of cells. These evidently serve to form a point of union between the endosperm and the embryo.

The author next considers the function of the so-called "endosperm collar" which lies between the calyx tube and the upper part of the hypocotyl. At this place the endosperm is thickened and has an uneven outer surface with tooth-like projections. These teeth or lobes extend in length and send strong haustoria into the calyx tube. The parenchyma cells of the calyx tube lying between these haustoria are marked by their large size and thin walls. Here, to all appearances, the developing embryo secures the greater part of its nourishment. In addition to obtaining food the endosperm collar has a purely mechanical function. The fruit of *Bruguiera eriopetala* falls off when the hypocotyl has reached a length of 8 or 9^{cm}. The young seedling at this stage possesses neither sufficient strength nor firmness, nor does it fall far enough to fix it vertically in the slimy soil. This position is secured by means of the firm, pointed calyx lobes which serve as an anchor. At the same time the strongly turgescent endosperm collar takes up water and increases considerably in thickness, thus acting as a wedge to separate the calyx from the hypocotyl and reminding one of the lodicules in grasses which, according to Hackel,[7] by their rapid swelling push away the glumes and thus effect the opening of the flower.

Haberlandt undertook a quantitative analysis of the chlorophyll in the hypocotyl of *Bruguiera eriopetala*, to ascertain whether there was a sufficient amount present for the necessary assimilative processes. He found the chlorophyll content of the hypocotyl to be rather more than half the amount contained in a single foliage leaf. He also found that in this species there are about five stomata to every square millimeter of hypocotyl surface.

Further investigations are necessary to determine whether other members of the genus Bruguiera possess haustorial cells arising from secondary endosperm, as was found to be the case in *Rhizophora mucronata*, although they do not appear to be of equal importance in the latter plant. In the myrsinaceous species studied, *Ægiceras majus*, the hypocotyl pierces the testa but does not enter the fruit, and the formation of endospermal haustoria takes place only in the region of the placentæ.

The paper here noticed is one of the many important contributions to botanical knowledge which have emanated from the Buitenzorg botanic garden. (Cf. BOTANICAL GAZETTE, **19:** 74. 1894.—G. H. HICKS.

[7] Ueber das Aufblühen der Gräser. Bot. Zeitung **38:** 432. 1880.

A contribution to the physiology of the genus Cuscuta.

G. J. Peirce brings out in the *Annals of Botany* for March, the results of his experiments on this interesting group of parasites, which has at various times received so much attention. It will be remembered that in a previous article Mr. Peirce described the origin, structure, and development of the haustoria of several species of Cuscuta and other parasites.[1]

It is found that Cuscuta during the process of attachment to a host plant or a support has two distinct methods of forming coils. In one case by circumnutation and geotropism the steep loose coils characteristic of the majority of twining plants are formed. In the other, closely wound tendril like coils are formed as a result of the irrito-contractility of a region of the growing tip of the stem. When a seedling starts from the soil, into which its roots scarcely penetrate, it begins a rapid circumnutation from left to right, and the region near the growing tip becomes very sensitive to contact of an upright plant or some body which will furnish nutrition. It forms around such objects two or more close coils by its power of irrito-contractility. On the inner side of these coils the growth of haustoria is induced by contact. The completion of the development of the haustoria and their penetration of the host, however, depends on the supply of nourishment derived from the host. The haustoria are able to pierce the tissues of the host by the mechanical pressure of the coils, and by the chemical action of the enzymes secreted by the haustoria, prehaustoria, and cushion cells.

After Cuscuta has thus become attached to a host, the stem below the point of attachment dies away, it climbs upward a short distance by the ordinary twining coils when it again forms another series of contractile coils with haustoria. After the first attachment is made, the growing tip becomes sensitive to contact with any solid object, but not to gelatine or liquids. By horizontal revolution on the clinostat the parasite loses the power to form the characteristic twining coils, since it is freed from geotropic influences. During this treatment it also become non-sensitive to contact, and does not regain its normal condition for several hours. This latter fact is unexplainable in the light of our present information on reactions to contact (unless it were possible that the jar-

[1] On the structure of the haustoria of some phanerogamic parasites. Ann. Bot. 7: 291. 1893.

ring of the clinostat has acted as a repeated stimulus, thus exhausting the power of response). The Cuscuta is placed in the limited category of twining plants which have the power of irrito-contractility. The comparison of its phenommena of this character, with those exhibited by tendrils are not always happily made, while throughout the paper the author seriously confuses climbing and twining plants.

Cuscuta is not markedly hydrotropic and exhibits only a weak heliotropism. The latter power is not in any way correlated with the amount of chlorophyll present, which varies inversely with the amount of nutriment received from the host. The high development of the power of movement and special senses of this parasite renders it a formidable enemy to succulent plants, whose only means of defense against it are firmness of cortex, size, and the possession of poisonous juices.

In places the article calls for the closest scrutiny of the context to bring out the meaning. The large mass of detail presented makes this obscurity in part unavoidable.—D. T. MAC DOUGAL.

BRIEFER ARTICLES.

Germinating seeds in sawdust.—Germinating seeds in sawdust is not so commonly practiced, we believe, as it might be, owing to the fact that sawdust frequently has a detrimental effect on root growth. In our intercourse with other teachers of botany we have often been reminded of this fact; and in many instances we have observed the roots of germinating plants grown in this medium to be in a very unhealthy condition.

For the benefit of those who use sawdust in germinating seeds, and have experienced difficulty in obtaining satisfactory results, we offer the following suggestions.

The difficulty lies in the selection of the sawdust. Care should be taken to select sawdust which contains no tannin, as this is the element which causes abnormal root growth. Roots grown in sawdust containing tannin show a reddish coloration, are crooked, and are very much reduced in size. In testing a number of different kinds of sawdust, we have found that that taken from the varieties of oak and chestnut should be avoided, since these woods contain tannin in sufficient quantities to cause the tannin poison. On the other hand, sawdust obtained from the conifers has no detrimental effect whatsoever to root growth.

The sawdust taken from hemlock, which is noted for containing large quantities of tannin in its bark, did not cause the tannin poison; neither did a water solution of the sawdust give a tannin reaction when tested with a solution of molybdate of ammonia in concentrated ammonium chloride. This is due to the fact that the tannin is located in the bark in this species and our sawdust was from heart-wood. That the abnormal appearance of roots grown in chestnut or oak sawdust is caused by tannin can be readily shown by saturating any sawdust suitable for normal growth with a 1 per cent. solution of tannin. If one has an unknown variety, or a mixed sawdust in which the elements are not readily recognized, a water decoction can be prepared and a portion of the same tested for tannin by one or more of the well known tannin tests.

In our opinion, no germinating medium is better than sawdust, as clean straight roots for class study or for experimental purposes can be readily obtained. We have never experienced difficulty with any sawdust which failed to give the tannin reaction, and during the past year we have used the same sawdust continually without changing.

We prefer a rather coarse sawdust to a fine one for general purposes. The seeds should be sown in well drained pots and watered at least once a day. It must not be forgotten, however, that roots germinating in sawdust or even in moist air or water, are slightly different from those grown in earth. The roots of sawdust cultures present characteristics in their growth which are closely allied to roots grown in moist air.—G. E. STONE, *Amherst, Mass.*

Note on the development of a filamentous form of Protococcus in entomostracan appendages. (WITH PLATE XXX.)—While examining a collection of *Sphæroplea annulina* brought in during the latter part of April, a very curious object was discovered under the microscope which at first sight might well have been mistaken for a new algal form. It proved to be fragments of the appendages of some entomostracan, presumably a Branchipus, in which a colony of Protococcus had obtained a foothold and was apparently in a very thriving condition.

The plant was an aquatic form, the collection having been made from submerged meadow lands. It agreed in every respect with the description given by De Toni of *Protococcus infusionum* (Schrank.) Kirchn., var. *Roemerianum* (Kuetz.) Hansg. The cells were of a bright green color, globose when free and angular in the crowded portions of the mass; the cell membrane was thin and the contents were homogeneous; the average diameter of the cells was about 10μ.

One fragment of the animal appeared to be a part of the antenna, having two long slender sensory hairs each furnished with one row of spines and a single short hair bearing two rows of spines. A second bit was made out to be probably a portion of the gills. Two lobes were each furnished with a row of hairs about $.5^{mm}$ in length and 17μ in diameter. These hairs were hollow and were very similar in appearance and size to the two long hairs of the antenna. A mass of Protococcus had formed in the broad basal portions of the structures and the cells were so numerous that they were crowded and pressed out of the natural form, becoming angular in outline and giving the appearance of a plate or layer of connected cells. Some of the cells had pushed their way up into the hairs, and undergoing division there had almost entirely filled the hollow lower half of each hair. Every hair then contained from one to four oblong masses of cells each mass being the result of the division of a single cell.

The common form of Protococcus consists of single cells lying together in a loose mass. Instead of this we here have filaments each composed of several cells. This is apparently brought about simply by the conditions in which the plant finds itself. Individual cells were forced up into the hairs whose walls, being transparent, gave opportunity for the admission of light, air, and moisture sufficient for the further growth and development of the cells. Division then taking place in the only direction possible from the shape of the enclosed space, a row of cells is formed which resembles in a marked manner filaments of Oscillaria.

This form of growth then affords a striking illustration of the effect of outward mechanical conditions by the modification into a filament, of cells which under normal conditions exist in simple masses or groups.—JOSEPHINE E. TILDEN, *Botanical Laboratory, University of Minnesota.*

EXPLANATION OF PLATE XXX.—Fig. 1. portions of a gill. Only one lobe is figured, the shape of the other being indicated by dotted lines. ×84.—Fig. 2, one of the hairs from the gill. ×450.—Fig. 3, an antenna. ×450.

Northwestern notes.—Lathyrus pauciflorus, n. sp.—Rather slender, two feet or more high: stipules broadly lanceolate and halberd shaped, an inch or more long, a third as wide, acuminate above, acute or obtuse below, usually coarsely toothed; leaflets three to six pairs, thickish, oblong-lanceolate or ovate-oblong, strongly apiculate, almost sessile, one or 1½ inches long: peduncles as long as or longer than the leaves, 3- or 4-flowered: flowers purple, an inch long; calyx teeth ciliate, the middle triangular-lanceolate ones twice as long as the upper triangular ones and two thirds as long as the lower lanceolate tooth; pods not seen.—Collected at Roseburg, Oregon, by Thomas Howell, June, 1887 (no. 677); at Wawawai, Washington, by Lake and Hull, June, 1892 (no. 810); and at Snake River Cañon, Washington, by C. V. Piper, May 27, 1893 (no. 1,487). This species has been confused with *L. polyphyllus* Nutt. from which it is distinguished by its few large flowers, fewer thickish leaves, and narrower stipules.

ROSA NUTKANA Presl, var. **hispida**, n. var.—A form of *R. Nutkana* made conspicuous by its strongly glandular, hispid receptacle and glandular calyx, though not otherwise differing from the type.—Collected at Rock Creek, Montana, by Dr. Watson, July 27, 1880 (no. 124); and at Pullman, Washington, by C. V. Piper, June and Sept., 1893 (no. 1,540).

Calochortus pavonaceus, n. sp.—Stems 10–20 inches high, from a small bulbous base, with a bract in the middle an inch or two long: leaves two-thirds as long as the stem, three or four lines wide, strongly involute in the dried specimens: the 1–4-flowered umbel subtended by as many unequal bracts, the longest rather longer than the pedicels; at least one of the pedicels becoming three inches long: sepals ovate-lanceolate, acuminate, glabrous, 1–1½ inches long, strongly flecked with violet within, the thin scarious margin almost transparent: petals cuneate-obovate, 1¼–1¾ inches long, the margin dentate and long ciliate, tending to become erose at the tip, violet above, yellowish below, with dark markings like the eye of a peacock's feather; gland small, covered with matted yellow hairs, bordered by longer ones, like those on the margin of the petal: anthers oblong, four lines in length, scarcely shorter than the broad-winged filaments: capsule broady elliptic to nearly orbicular, an inch long, with a short, stout beak.—Collected at Pullman, Whitman Co., Washington, by L. F. Henderson, June, 1892 (no. 2,484); and by C. V. Piper, 1893 (no. 1,680); and at Union Flat, Whitman Co., by Lake and Hull, July, 1892 (no. 618). A species near *C. nitidus* Dougl., but well distinguished by its colored petals, and relatively long anthers and short filaments. Mr. Piper's no. 1,681, from Pullman, seems to be *Calochortus macrocarpus* Dougl., though the petals are white, with or without blue markings at their bases.—MERRITT LYNDON FERNALD, *Gray Herbarium, Cambridge, Mass.*

Cross fertilization of petunias.—This series of experiments in cross fertilizing the ordinary purple petunia, were continued until the third generation was obtained. The same precautions against accidental fertilization were used, as described in the previous notes published in this magazine for October, 1892.

The results obtained from the last generation were somewhat more conclusive than from the first, as would naturally be expected, yet the variation in this case was no more than would usually occur in three generations.

The variegated varieties showed the same lack of vitality and productiveness, throughout all the generations. The plants were smaller, weaker, and much less productive than the plain purple in almost every case; but a few plants which seemed as large and as vigorous as the average purple ones bloomed less freely; only a few of these blossoms produced seed capsules, which were always smaller.

The seeds obtained from the first year's experiments were all planted the same day, under exactly the same conditions and their germination was carefully watched and noted every day. No. 1 (self-fertilized), no. 2 (fertilized from a different flower on the same plant), and no. 3 (cross fertilized), were all sowed in the same box with only a thin board partition between, so that there could not have been the slightest difference in their conditions while germinating.

The variegated variety germinated more slowly and less vigorously than the purple; while many of the seeds failed to germinate at all.

On the seventh day a large percentage of no. 3 appeared above ground, while but four of no. 1, and none of no. 2 were up yet. On the eighth day a few of no. 2 appeared, a few more of no. 1, and many more of no. 3 were above the soil. The seeds all continued germinating at intervals for over two months, though all germinating after the second week were less vigorous than the first.

From the time of germination until the plants died, no. 3 seemed much more vigorous and healthy; while no. 2 stood next, and no. 1 last in rank as over half the plants of the latter died before maturity.

The table below will show some of the chief differences in size, productiveness and vigor of the three series, 1, 2, and 3.

	First generation.			Second generation.			Third generation.		
	1.	2.	3.	1.	2.	3.	1.	2.	3.
Average days germinating	....	....	....	14	14	10	....	....	....
Per cent. germinating	....	....	....	5	15	95	0	10	95
Height, inches, at four months	....	....	....	4	6	7	....	....	....
Height, inches, at six months	....	....	....	10	12	13	....	....	....
No. blossoms	126	95	134	40	70	121	....	....	....
No. capsules ripened	24	21	48	3	37	50	....	....	....
Aver. weight capsule in milligrams	19	27	41	1	16	44	....	....	....
Per cent. blossoms producing seed	19.4	22.5	35.2	9.6	61.6	50	....	....	....

A number of blossoms from each series were accidently destroyed in various ways; but these were subtracted from each number before the averages for seed capsules were made.

It will be seen by this table that the same conclusions may be drawn as before; namely, that self-fertilization tends to weaken the plant, and also to lessen its productiveness; while cross fertilization has just the reverse effects. The crossing of different flowers on the same plant is no doubt better than self-fertilization; though not nearly so good as cross fertilization. There seemed to be a larger percentage of no. 2 producing seed; but the seed capsules were many of them almost empty, while all were much smaller, usually less than one third as large as no. 3. The third generation was planted but no. 1 failed to germinate, so that the plants were not cared for longer.—MINNIE REED, *Kansas Agric. College, Manhattan.*

Trillium cernuum L.—Monstrosities in the genus *Trillium* are not rare, but two unusually singular forms from Canobie Lake, Windham township, N. H., may be worth putting on record.

The plants are of the usual size and in each there is the normal whorl of leaves. In one plant, lifted about one inch above that normal whorl on the stem, are three more whorls of three leaves each set closely together, making a pretty rosette, and above those is the flower erect. Sepals rather larger than common; petals 11^{l} long and 4^{l} wide, with a white stripe running down the center, and a green one on each edge; stigmas four; one of the petals two-parted.

In the other plant a rosette of two whorls; a third abnormal whorl inthis specimen also, but lifted half an inch above the others to the base of the flower. Petals green and white; one stamen abortive; stigmas two. The rosettes pressed and mounted measure in one plant 5^{in} 10^{l} across, in the other 4^{in} 11^{l}.

The upright flowers suggested T. grandiflorum, but the stigmas, distinct and recurved,and the short stamens are perhaps enough to prove the species to be cernuum; moreover, I learn that T. grandiflorum has never been noticed in that vicinity, and that T. cernuum is common where these plants were found. They were collected by a very youthful observer, Miss Anna Dimmock, who writes to me that there were several other similar specimens where she gathered those which she sent here. —MARIA L. OWEN, *Springfield, Mass.*

An abnormal Hepatica.—A peculiar form of *Hepatica triloba*, collected near Boston, was brought to me recently. The peduncle, which is very flat, though not much larger than usual, is doubtless a case of fasciation. The involucre consists of seven green bracts of unequal size, one with a white streak on both sides. A normal flower of nine semi-white sepals is in the normal position. Another smaller flower, of six white sepals, is crowded between the larger flower and the involucre on a short pedicel. This flower has an involucre of three bracts, one green, and two of a variegated green and white color. Both flowers have the usual number of stamens and pistils.—WALTER DEANE, *Cambridge, Mass.*

EDITORIAL.

THE era of machinery appears to have arrived for American botany. It was probably inevitable whenever physiological studies attracted sufficient attention to take a prominent part in the curriculum. But just the manner and time of its advent could hardly have been anticipated. The elaborate auxanometers, clinostats and other special pieces used in foreign laboratories, made familiar to American botanists through books and journals, described by visitors to Tübingen, Leipzig, Cambridge, Vienna and other famous centers of research, and of which a sample instrument has occasionally been purchased for the general equipment of a laboratory in this country, seemed too expensive and too difficult to obtain ever to become common in America.

At first very simple appliances served the teacher's purpose. The demonstration of transpiration was made by passing a fresh sprig through pasteboard over a tumbler of water, and inverting another tumbler over it, and heliotropism was shown by setting a plant before a window. The need of accurate records led to the adoption of various mechanical methods. Special devices for demonstrating growth were first brought forward. More than a decade ago Professor Bessey's arc indicator became well known, and a few years later the rather elaborate machines devised by Professor Barnes and Mr. Bumpus were figured and described in the journals, and very recently Miss Golden's auxanometer has been described. About three years ago Mr. Swezey described a centrifugal apparatus for studying geotropism, and two years ago Professor Thomas illustrated and described an apparatus for recording root pressure. Other apparatus has from time to time been devised and some of it described in the journals or before societies. But none of these pieces could be obtained in the market. Each laboratory was still obliged to make its own apparatus, or import from foreign makers.

The first pieces of physiological apparatus emanating from an American laboratory, duplicates of which could be purchased, were an auxanometer and centrifugal apparatus originating at Purdue University, and displayed at the Madison meeting of the A. A. A. S. last year. The considerable number of laboratories which have availed themselves within the year of the chance of securing these pieces of apparatus, shows that the plan of offering newly devised apparatus for sale meets with favor.

A circular recently distributed from the botanical laboratories of the University of Minnesota offers the botanical public three ingenious pieces of apparatus: an electrical auxanometer, a registering balance, and a recording apparatus to be used with either of the preceding.

While visiting the botanical laboratories of Wabash College a short time since the writer saw a beautifully made apparatus for recording root pressure, of which duplicates can probably be obtained shortly. There may be other laboratories ot research, fortunate enough to command the services of skilled mechanics, already contemplating sharing the results of study and skill with their fellow workers. Certainly we should not be surprised to hear of such, now that the method is fairly inaugurated.

American botanists are an enthusiastic class, and are credited with being well endowed with the proverbial ingenuity of the Yankee, so that having turned their attention to providing their own mechanical devices for studying plants, many compact and efficient designs may be confidently anticipated.

The movement is one to be highly commended. It is only second to the supply of suitable text books in its power to advance the interests of the science of physiology in the higher institutions of learning. It is clearly the precursor to more accurate methods of research in the several lines requiring close measurement. As such instruments become more common, finer methods will prevail, more delicately adjusted machines will be demanded, and more profound studies will be possible. It is one way, possibly the only way, by which American laboratories can hope to attain to a position that will enable them to equal those of Europe in the lines of research requring such apparatus.

Other claims for the wide reaching influence of this movement might be made. It is at least likely to liberalize the prevailing views regarding the requirements for a well equipped laboratory.

CURRENT LITERATURE.

Manual of Vegetable Physiology.

A guide to laboratory exercises in vegetable physiology, the first published for the use of English speaking students, has just been issued from the press of Morris & Wilson of Minneapolis, Minn.[1] This valuable addition to the aids for teaching physiological botany is the outcome of the needs of the flourishing department of physiology in the University of Minnesota. The work is a translation of Oels' *Pflanzenphysiologische Versuche*, published less than a year ago, and intended for the use of middle class schools. The translation has been prepared and printed primarily for the convenience of students in the University of Minnesota, but it has been put into such good shape, and the original text is so admirable that it will prove specially valuable wherever elementary physiology is taught.

The translator has taken great liberties with the Roman-paged prelude to the text proper, but the body of the work has been rendered into English with fidelity, the only change of moment being the substitution of the word "photosynthesis" for that of "assimilation." This change follows from a suggestion by Dr. Barnes, made a year ago before the American Association at Madison, who clearly pointed out the need of a distinctive term for the synthetical process in plants, brought about by protoplasm in the presence of chlorophyll and light. He proposed the word "photosyntax," which met with favor. In the discussion Professor MacMillan suggested the word "photosynthesis," as etymologically more satisfactory and accurate, a claim which Dr. Barnes showed could not be maintained. The suggestion of Dr. Barnes not only received tacit acceptance by the botanists of the association, but was practically approved by the Madison Congress in the course of a discussion upon this point. In the interest of harmony, therefore, even if courtesy be ignored, the word substituted for assimilation, if any were to be inserted, should have been "photosyntax" and not "photosynthesis."

The text is made up of eighty-eight paragraphs of general statements of fact, introducing the experiments, one hundred and twenty-two in number. The illustrations show clearly how the work is to be

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[1] OELS, WALTER: Experimental plant physiology; translated and edited by D. T. MacDougal. pp. x + 86. figs. 77. 8vo. Minneapolis: Morris & Wilson. 1894. $1.10.

done. The experiments are well selected, and not difficult to perform. A few are by no means likely to afford the degree of success that the description of the process would indicate; but this comes from inherent difficulties, and to give all necessary precautions would be likely to frighten the beginner from any attempt, which would be worse than to try with but partial success Some of the experiments call for considerable knowledge of manipulation on the part of the instructor. However, it would be difficult to select a more satisfactory series of experiments on the whole, to illustrate the main facts of the science. Moreover, it is not necessary to use the whole series in order to present an acceptable outline, and selections can be made to meet special requirements.

The apparatus required is of the simplest kind, and is not difficult or expensive to provide.

The majority of the experiments are of the qualitative type, and all, even the quantitative ones, are specially designed for beginners, no attempt being made to indicate the precautions or niceties of manipulation required for strictly accurate and authoritative work.

The last chapter, a short one of a page and half, on the relation of plants and animals, does not properly belong to the subject of physiology, but to that of ecology, and its omission would be preferable.

The translator has added a page of equivalents of English and metric weights and measures, and an index to the plants mentioned in the text, for which all students will be grateful.

The printers have done fair work; some minor defects may be overlooked as due to inexperience in book-making. The paper and binding, the latter flexible cloth, are well suited to a laboratory manual.

Minor Notices.

DURING the summer of 1893 the Michigan Fish Commission sent a party to study the flora and fauna of Lake St. Clair. Mr. A. J. Pieters was botanist of the party, and he has now published "The plants of Lake St. Clair" as one of the bulletins of the Commission. The work is based upon that of Magnin in the lakes of the Jura. The flora was found arranged in zones limited by the depth of water, and having certain plants characteristic of each zone, although Magnin's Nupharetum did not exist.

DR. WILLIAM TRELEASE has published an interesting account of Leitneria Floridana, distributed in advance of the sixth annual report of the Missouri Botanical Garden. Mr. B. F. Bush discovered this species in 1892 in the lowlands of S. E. Missouri, the plants being more robust than those of Florida, and associated with other Gulf species. There seems to be here an indication of the northern extension of the Gulf flora along the deep swamp-lands of the lower Mississippi. Leitneria is also reported from the Brazos in Texas, but there is some uncertainty as to the locality. A remarkable feature of Leitneria is its lightness, being the lightest of all known woods, with a specific gravity of 0.207, while ordinary cork is given as 0.240. Dr. Trelease has made a careful study of the anatomical structure of the stem, and illustrates it by the reproduction of several excellent photomicrographs. Fifteen full-page plates are given.

MR. JARED G. SMITH has published an excellent revision of the North American species of Sagittaria and Lophotocarpus, distributing it in advance of the sixth annual report of the Missouri Botanical Garden. Dr. Engelmann's notes and types served as a foundation for the work. Leaf forms prove very unsatisfactory in classification, and the least variation is found to be in the form and size of the achenium, form of the anthers, pubescence or not of the filaments, relative length of fertile and sterile pedicels, etc. Twenty-two species are recognized, three of which are Mexican, and several new, and much-tangled synonymy is straightened out. Following Buchenau and Micheli, Lophotocarpus is separated from Sagittaria. Twenty-nine full page plates accompany the revision.

THE THIRD and last part of Dr. John M. Coulter's "Manual of the Botany of Western Texas" has been issued by the Department of Agriculture. It contains the apetalæ, monocotyledons, gymnosperms, and pteridophytes. The Juncaceæ are contributed by F. V. Coville; Carex by L. H. Bailey; Gramineæ by L. H. Dewey; and Pteridophyta by L. M. Underwood. This completes, in a handy volume, the presentation of the flora of a very interesting region, whose local study was seriously interfered with by the scattered and inaccessible nature of the publications that dealt with its plants. The need of such a work has been attested by the fact of a much larger demand for the earlier parts than could be supplied.

Two "Contributions" have just been issued from the Gray Herbarium; one by Dr. B. L. Robinson (Proc. Amer. Acad. 29: 273–330), and the other by Dr. Robinson and Mr. J. M. Greenman (l. c. 382–394). In the former Dr. Robinson presents a revision of the North American Alsineæ, a continuation of his study of the Caryophyllaceæ. Of the native species Cerastium contains 16 species and varieties, Stellaria 26, Arenaria 46, Sagina 9, and Spergularia (retained instead of Tissa, thus adding to the synonymy of this much vexed group) 11. The rest of the contribution and also the second one are devoted to descriptions of plants from the Pringle collections of 1892 and 1893.

NOTES AND NEWS.

Mr. Frederick Le Roy Sargent has a series of articles on the pollination of orchids in the recent numbers of the *Popular Science News*.

Mr. T. H. Kearney, Jr., has been appointed to the curatorship of the Columbia College herbarium, as successor to Dr. Morong, deceased.

Bokorny has shown experimentally (Archiv. f. Hyg. 20:—.1894) that chlorophyll-bearing aquatic plants are highly efficient in purifying natural waters containing sewerage.

In the annual report of the Connecticut Station for 1893 Dr. W. C. Sturgis gives (pp. 72–111) information about many plant diseases with much helpful matter relating to treatment.

Peach yellows and rosette are ably described and discussed by Dr. Erwin F. Smith in a twenty page bulletin from the U. S. Department of Agriculture, no. 17 of the farmers' series.

The second annual report of the Ohio Academy of Science is a pamphlet of 52 pages. It includes seventeen short papers or abstracts relating to botany, several of which are lists of Ohio plants.

A Science Club has been organized at Indianapolis, Ind., to promote local interest in scientific subjects and foster good fellowship among resident scientists. Pleasant club rooms have been secured in the Denison Hotel. Mr. John S. Wright is the present secretary.

Material for class use, both alcoholic and dry, and also some living material, can be obtained of the Cambridge Botanical Supply Co. This will prove a great service to many teachers who prefer to buy rather than to collect, or who need some special sorts to complete their list.

In recent numbers of the *Beihefte zum Botanischen Centralblatt* Dr. A. Zimmermann has gathered together the recent literature relating to the plant cell and has presented a summary of the more important contributions. This supplements his work *Die Pflanzenzelle*, and brings information up to date in a most useful manner.

Bacterium Zopfii has been found by Boyce and Evans to be strongly apogeotropic when grown in nutrient gelatine (Centr. f. Bakt. u. Par. 15: 568), and by Beyerinck to be thermotropic (ibid, 799). The last investigator suggests that the sensitiveness to warmth doubtless enables the organism to more readily penetrate the animal body, for it is parasitic upon the domestic fowl.

A critical notice of Mr. Ganong's paper on the absorption of water by the green parts of plants (this journal, *ante*, p. 136) appears in *Agricultural Science* for March (recently issued), written by Mr. J. Christian Bay. The methods employed are severely criticised, after which a résumé of the literature of the subject is given, extending from the time of Mariotte and Bonnet to the present.

A NEW YEAST has been found by M. W. Beyerinck (Centr. f. Bak. u. Par., 16: 49–58. 1894) upon Zante currants. It is called *Schizosaccharomyces octosporus*, the genus containing only one other species, an east African form. As the name indicates, it forms eight spores in a cell. It is capable of fermenting glucose and maltose, but not sucrose, lactose or arabinose. It makes but feeble growth in a solution of cane sugar.

VEGETAL PARASITISM among insects is the subject of a paper of nineteen pages and three plates in the Quarterly Journal of Proceedings for April of the Columbus (Ohio) Horticultural Society, written by Prof. F. M. Webster. It includes much valuable personal observation and experiments. A classified list of entomophytes of the families Hypocreaceæ and Entomophthoraceæ enumerates 87 species of fungi with their insect hosts and distribution.

THE CARD INDEX of genera, species and varieties of plants published since 1885, prepared by Miss Josephine A. Clark of Washington, has met with much favor. The series is carefully prepared and can not fail to be of great assistance to any working botanist. All classes of plants are included. There are between one and two hundred cards of fungi in each thousand, and for the convenience of mycologists it has been proposed that these be also issued separately. Miss Clark has consented to this proposition, if a number of mycologists will send in their subscriptions soon. The separate index of fungi will be sold at the rate of $1.75 per hundred cards.

AN EXPEDITION through eastern Africa for the collection of natural history specimens, and to secure photographs, will start from Pretoria, South African Republic, about August 1st, and passing through Matabeleland, the extreme western portion of the East African Portuguese possessions, and along the western coast of Lake Nyassa, will reach Zanzibar after about twelve months. Although all kinds of material of a scientific character will be collected, plants and insects will receive the chief attention. Sets of either of these are offered at $10.00 per century. Those desiring to place orders should address The Kaessner Expedition, care of Imperial German Consulate, Zanzibar, East Africa.

A VERY SATISFACTORY enumeration of the departments into which the science of botany is at present divided (although exceptions may be taken to the nomenclature) is given by Prof. W. F. Ganong in a communication to the New Brunswick Natural History Society, published in the June number of the *Educational Review* of St. John, under the caption "An outline of phytobiology." He makes eleven chief departments, as follows: I. systematic botany, II. phyto-anatomy, III. phyto-morphology, IV. phyto-physiology, V. phyto-pathology, VI. economic botany, VII. botanical geography, VIII. phyto-palæontology, IX. folk botany, X. philosophical botany, XI. phytobiology. The author points out that the amateur can do little to advance the science in departments II, IV and X, that he can do some small service in III, V, VI, VII and VIII; and very important service in I, IX and XI. The object of the paper is to promote the biological study of Acadian plants by local botanists, but it will interest and benefit other American botanists as well.

BULLETINS FROM THE EXPERIMENT STATIONS for the last month show more than the usual diversity of subjects. Spraying to destroy insects and fungi by S. T. Maynard (Hatch, Mass. no. 25) includes results of the application of Bordeaux mixture upon poplar rust (Melampsora), with two fine plates. Cotton-boll rot by J. M. Stedman (Ala. no. 55) details the study of a new disease of cotton affecting the seeds, lint and bolls, caused by bacteria, with one plate. Second report on rusts of grains by A. S. Hitchcock and M. A. Carleton (Kan. no. 46) gives valuable experimental studies of *Puccinia graminis* and *P. rubigo-veria*. The conclusion is reached that the latter persists through the winter in wheat plants in the mycelial condition, but that the former does not; that rusts of the same species upon different hosts are races which can not be transferred from one kind of host to another, i. e. P. graminis on oats will not infect wheat, etc.; and that spraying for rust on cereals is possible but not practical. Noxious weeds by E. S. Goff (Wis. no. 39) treats of the ten weeds of the Wisconsin weed law, and also of Russian thistle, with illustrations. Some recent Chinese vegetables by L. H. Bailey (Cornell N. Y. no. 67) gives an interesting account of a number of cultivated plants, with their Chinese names, and illustrations.

ACONITUM UNCINATUM is found by David F. Day (*Meehan's Monthly*, 4: 117. Ag 1894) to be an intermittent twiner, as it makes one or two turns about a support, then grows straight for a few inches, when it again makes a turn or two, thus attaining a height of six or seven feet. The fact that the species twines was recorded by Elliott in his sketch of the botany of the Carolinas, 2: 20, but its intermittent character has not before been observed. Plants of this species and of *A. Noveboracense* have been grown by Mr. Day in his garden, and their habits carefully watched. The latter species shows no tendency to twine.

DIETEL on UREDINEÆ, etc.

TILDEN on PROTOCOCCUS.

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In the October number will appear:

Filices Mexicanæ. V., by GEORGE E. DAVENPORT, *Medford, Mass.*

Notes on Cribraria minutissima and Licea minima, by DR. GEORGE A. REX, *Philadelphia, Pa.*

Eduard Strasburger: a bibliographical sketch, by JAMES E. HUMPHREY, *Weymouth Heights, Mass.*

Noteworthy anatomical and physiological researches.

BOTANICAL GAZETTE

SEPTEMBER, 1894.

The evolution of the Hepaticæ.

Vice-presidential address before section G, A. A. A. S.

LUCIEN M. UNDERWOOD.

There is, perhaps, a natural tendency among specialists to magnify the importance of the particular subject or group of life forms in which they happen to be specially interested. The horticultural botanist, dreaming of the time when the world will be reorganized through the products of his art, is prone to see nothing beyond utility and ornament in plants, and it becomes a part of his nature to see some useful character in forms of vegetation which to others are devoid of either beauty or utility. The economic mycologist, over-impressed with the magnitude of the losses sustained by the unfortunate agriculturist and fruit grower, is haunted in sleep with visions of anthracnose and mildew, and in his waking hours sees little in botany but host-plants bristling with parasites and Bordeaux mixtures certain to relieve them of their incubus. The man with inherent, if not coherent, proclivities for priority, with a war-like temperament and a strong tendency to cross lances, sees in botany one vast battle field of synonymy in which cohorts of pre-Linnaean binomials, hordes of decapitalization dogmas, hostile homonyms and Kuntzian curiosities charge down upon each other in battalions, form and *reform* in utter confusion. There are some microscopic botanists whose degree of specialization never permits them to look outside the limits of an apical cell; and others still whose botanical horizon is bounded by the field of an immersion lens and whose azimuth and right ascension are calculated within its limits. We are all more or less inclined to ride our own hobbies in public places, so in performing the initial function of this office, I can perhaps do no better than to bring forth mine. In this way, I shall at least be in touch with present custom.

With no desire, however, to overestimate its importance, I wish to place before you the position in the botanical system of a comparatively obscure group of plants and to call your attention for a brief time no less to their own differentiation than to their important relation to the evolution of the plant world. I desire to set forth in something of a reasonable way the characters of the group and to correct some misunderstandings that have resulted from an imperfect appreciation of its relations. The group commonly known as Hepaticæ has suffered at the hands of general botanists, and through them an incomplete and one-sided conception is transmitted to the generation of botanical students now coming to their maturity. The average text-book of botany emphasizes strongly the representative character of Marchantia polymorpha. In elementary laboratory guides, this is even made to stand as the sole representative of all the bryophytes. In those somewhat more comprehensive, it is made a type of the more limited group, the Hepaticæ, and in even the most complete it is made to stand pre-eminent as the representative of this triply developed group of plants, notwithstanding the fact that the other members of this trio are vastly more important—one in the nature and extent of its development *per se*, and the other in its important relations to the development of the higher groups of the plant world. One elementary text-book that has in general done much to elevate the standard of botanical teaching in America during the past decade opens its account of the Hepaticæ with these words: "In the liverworts the plant body is for the most part either a true thallus or a thalloid structure. When there is a differentiation into stem and leaves," etc. This statement may be taken as fairly representing a conception of the group common among botanists and botanical teachers. The hepatics among us are popularly supposed to be thallose or thalloid plants and Marchantia is regarded as a normal representative. As opposed to this wide-spread misconception, it should be noted that as far back as the date of the last publication of a general synopsis of the Hepaticæ (1847) the relative numerical importance of the Marchantiaceæ was only 17 per cent. of the entire group and the increase since that time has been even more largely in the direction of the other groups, especially the foliaceous Jungermaniaceæ which represent at once the most numerous and best differentiated types of the Hepaticæ.[1] It would be even less a misrepresentation of the Musci to make its representatives in Andreaea, Phascum or Buxbaumia than to place Marchantia or any of its allies as a normal representative of the Hepaticæ. Armed, however, with such a conception gained from the elementary texts and emphasized by the works of reference usually accessible in an ordinary laboratory, as for example Kny, Strasburger, Sachs, and Goebel, the student goes forth into the field to study liverworts and after he has exhausted Marchantia and Conocephalus, and has possibly seen a Riccia, he is usually stranded and knows not what to seek. In fact, many are more likely to confuse some such thallose lichen, as Peltigera, with liverworts than to look for them among leafy forms which their training has not rendered them able to properly correlate. The Lophocoleas, the Cephalozias, the Frullanias and the Radulas, so elegant in their structure as to impress the least æsthetic student with their beauty, so diversified in their evolution as to demand the exercise of his most active powers of reflection, and withal so simple in structure as to render them accessible with a minimum of microscopic technique—these are a closed volume to him because of the limitations of his early instruction and impressions.

The group known since the time of Adanson as the Hepaticæ stands in a unique position on the boundary line of thallose and leafy plants, and its position is not only intermediate from the structural standpoint, but in its relation to the evolution of the higher plants it stands as a key or link between the lower and simpler and the higher and more complex. The group is not a compact one nor are its component groups closely united to each other. It is even to be doubted if a good reason exists for the separation of the bryophytes into the two classes Musci and Hepaticæ, and it would be hazardous to attempt their separation as coordinate groups on any rational grounds, even if we leave in question their relation to the Sphagnaceæ.

[1] The relative extent of the Jungermaniaceæ as developed by modern exploration and subsequent study can be seen in a comparison of a few representative genera:

	Species described in Synopsis Hepaticarum 1844-47.	Species reported by Schiffner 1893.
Metzgeria	8	36
Lophocolea	69	149
Plagiochila	179	463

The hepatics possess almost absolutely no utilitarian aspect. Beyond the doubtful use of one or two in medicine, and the occasional occurrence of one or more tropical species as weeds, they are, so far as the physical condition of the human race is concerned, an entirely useless group of plants. They do not trouble the experiment station botanist, the horticulturist finds no use for them, and the general public does not see sufficient importance in them to subscribe a single shilling for the endowment of a laboratory for research in such an apparently barren field. And yet from the higher standpoint of genetic relationship, there is probably no single group of plants that occupies such an unique position in the plant world. What the comprehensive and heterogeneous group "Vermes" is to the animal kingdom, the Hepaticæ are to plants, with this difference, that we have here a much less complicated group of organisms with which to deal.

To understand more fully the relation of the Hepaticæ to the evolution of the green plants and particularly to their role in the development of the alternation of phases of reproduction which has attained such extended proportions in the ferns and other pteridophytes, it is desirable to bring in brief review the successive stages in the processes of reproduction from the simplest forms upward. For it must be remembered that even if the methods of reproduction cannot serve as the means of separating the primary types of the thallophytes in a natural system of classification, they nevertheless represent the highest function that is manifested in organic life. The successive stages may be characterized as follows:

I. Among forms whose only method of reproduction consists of fission, in which the individual life begins with the completion of the karyokinetic process of cell division and closes when its individuality is lost in the next generation produced, the type of the life history of the organism may be represented by a straight line whose terminations bear no relation to each other. There is no round of life history, no cycle of development where fission is the law of reproduction.

II. Among forms in which conjugation occurs, we have successive stages of distinct sexual reproduction occurring before the idea of bisexuality has been differentiated. Two purposes seem involved in this process, (1) the increase of vitality by the union of elements of separate origin, and (2) the production of a structure capable of holding vitality more certainly through critical changes of environment; hence the resting-spore. We have here a type of life history where continuity commences to curve into a circle and its ends begin to unite to form a complete cycle of development. In many forms, however, the individual is too hopelessly entangled in colony life to be clearly separated.

III. In forms (like Vaucheria) where the sexual cells are clearly distinguishable from the early commencement of the process of reproduction, and the oospore results directly and simply from the act of fertilization, the life history of the plant may be clearly said to be represented by the circle. The phase of growth is purely a sexual one from spore to germinating filament through the production of sexual apparatus to spore again. If asexual reproduction occurs, it merely serves to rapidly multiply the plant when favoring environment makes it possible, and bears no relation to the sexual process and is not dependent upon it.

IV. Among some of the higher algæ occurs the simplest form of alternation of phases of reproduction. While there are various modifications of the process in minor details in many groups of algæ, the act of fertilization in certain representative forms is followed (1) by the formation of a special envelop of cells about the oogone as a specialized protective covering, and (2) by the division of the cell contents of the oogone into a series of reproductive bodies, an asexual process following as a result of a sexual one and therefore dependent on it. The life history here, instead of representing a simple cycle of growth, can be best characterized as a combination of two loops each short of a circle, the larger representing the sexual stage from germinating spore to the completion of the process of fertilization, and the smaller representing the asexual phase involved in the internal cell division that results in the development of the reproductive bodies. The so-called "alternation of generations", which is nothing more than the succession of phases in the life history of the organism, commences at a point considerably below the lowest bryophytes.

V. The transition from the above condition to that which we find in the lowest archegoniates is a simple one. The advance manifests itself in the following particulars: (1) in the protective envelop of the egg cell being developed prior to the act of fertilization and not as a result of it; (2) in the somewhat more complex development of the asexual phase (sporogone) in the formation of a definite multicellular wall and the division of the interior by a double process of cell multiplication. Most of these details even are more or less feebly foreshadowed in some of the higher algæ. The only modification necessary in the diagrammatic representation of the lower bryophytes as contrasted with that of the higher algæ is the relatively greater development of the asexual phase which is therefore represented by a proportionally larger loop. The lines of specialization which have resulted from the varied differentiations of this simple type will be discussed more in detail later in this paper.

VI. The highest development of the principle of alternation of phases of reproduction is illustrated by the well known climax reached among the pteridophytes in which the asexual phase represents a degree of specialization utterly disproportionate to the simple sexual phase (prothallus) which has scarcely advanced beyond the primitive condition reached by the lowest archegoniates. The diagrammatic representation of the life history of the fern is therefore a reversal of that of the higher algæ, the larger loop representing the highly differentiated asexual phase and the smaller the simple thallose sexual phase.

The high degree of differentiation of the asexual phase of the pteridophytes coupled with the great antiquity of the group have rendered them a stumbling block to many who have not been careful in tracing their homologies. In the evolution of the pteridophytes, however it must be remembered that the line of descent must be sought, not in a comparison of the highly developed asexual phase of the one with the simple sporogone of the other but along the line of the simpler sexual phase. When we consider this feature of the development in its proper light, the progress of evolution from alga to fern is greatly simplified and the distance between the groups either in the time necessary for the derivation of the one from the other or in the slight degree of differentiation manifest in these coordinate phases, is reduced to a minimum. From higher algæ to simple prothallus the transition is not a difficult one. In regard to the other feature of the problem, it may be suggested that the development of the asexual phase of fern-like plants which dates back to the Devonian and reached a high degree of specialization in the Carboniferous, may have been strongly influenced and perhaps rapidly evolved by the peculiar environment of precarboniferous times; at least the statements of the books in reference to the excessive amount of carbonic oxide in the atmosphere being peculiarly adapted to the growth and development of the lower pteridophytes would support such a hypothesis. On this point, however, it may be questioned whether the statements of the books do not need some modification.

I have said that the Hepaticæ have undergone a triple differentiation. Commencing with a simple thallose plant with its unmodified sporogone, it is evident that there are three possible lines of specialization: (1) the development of the thallus as such; (2) the transformation of the thallus into a leafy axis combined with the modification from creeping to ascending or erect habit; and (3) the specialization of the sporogone at the expense of the thallus. Even a cursory acquaintance with the diverse structures that are developed in the group will make it evident that the Hepaticæ have improved their opportunity in each of these three possible lines and have carried the differentiation of each line to a high degree of perfection. Let us follow out in some detail these three lines of development.

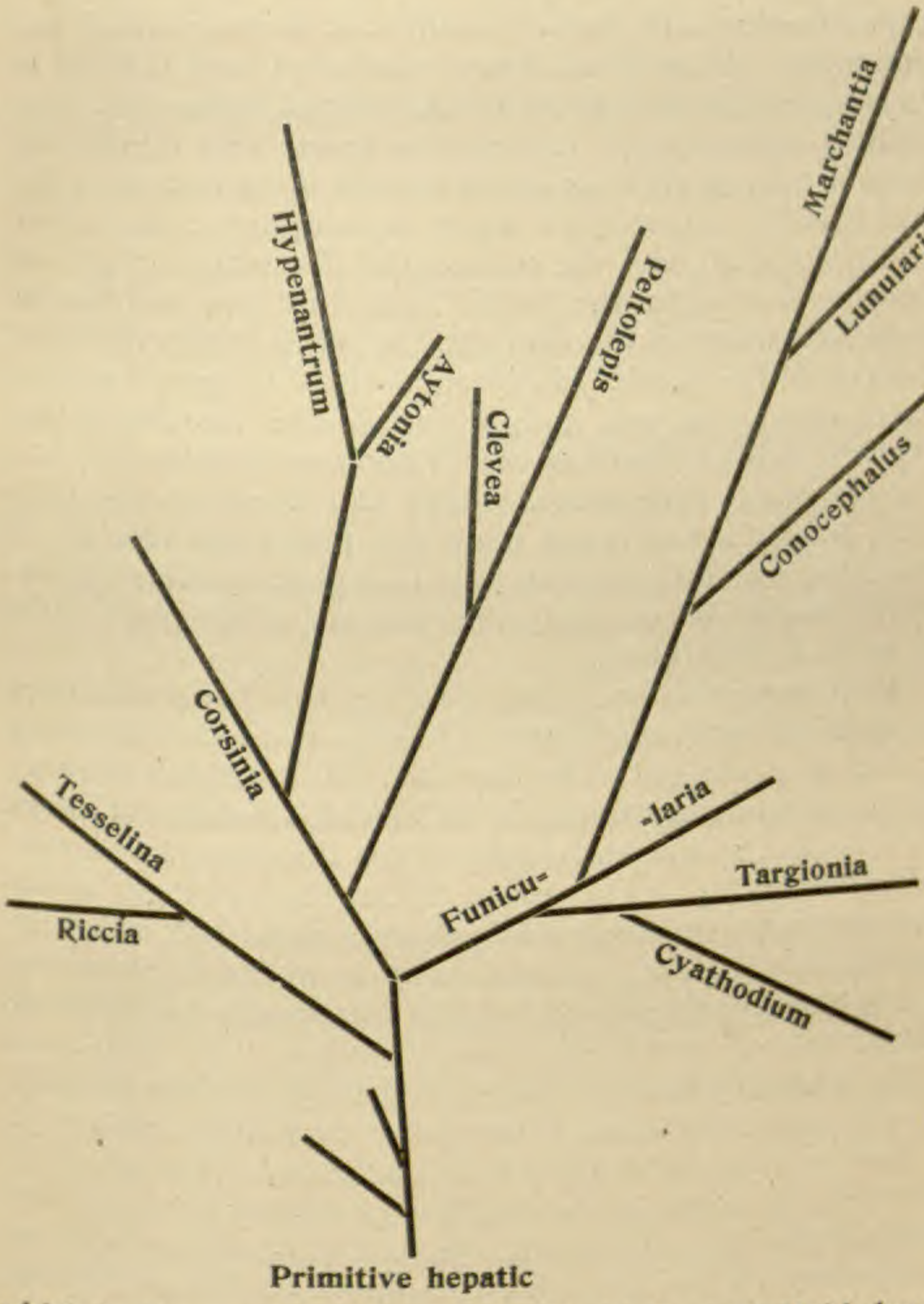
I. *The Marchantiales.* We must place as lowest in the series the group which commences with such simple types as Riccia and Tesselina and ends with the elaborate Marchantia and its congeners. Among the lowest types the habit is not greatly different from that of the algæ, the plants either floating in water or attaching themselves to wet soil. The capsular development in the lower forms moreover is not very diverse from that of certain of the higher algæ, the sporogone being without stem and often imperfectly surrounded by a capsular wall. As we advance to higher forms, we find not only an extensive modification of the thalloid structure necessitating an elaborate system of stomata and in many cases specially modified branches for the better accommodation of the reproductive bodies, but also a striking advance in the capsular development in which the egg cell develops not only a capsule or fertile portion, but also a stalk or sterile portion, which with the addition of elaters formed within the capsule, better serves to distribute the spores.

We may note here also two types of differentiation in the specialized branch that bears the carpocephalum, as it explains some seeming anomalies in the fruiting habits of some of our common Marchantiaceæ. The impression has prevailed and is now wide spread that while Marchantia may commonly be found in fruit, Conocephalus rarely produces it. The fruiting branch of Marchantia is developed before the maturity of the sporogone is reached. This branch is therefore firm and consequently persistent. The botanist who only rarely comes in contact with plants except as they are preserved in herbaria or imbedded in celloidin has considerable opportunity to see the fruit bearing branches of Marchantia as they are developed, long before the spores are mature and persist long after the spores are scattered. On the other hand, Conocephalus, whose archegones are fertilized during the late summer or early autumn, matures its capsules within the carpocephalum before the fruit bearing branch of the thallus is developed. In this condition it passes the winter and with the earliest return of spring the reserve material of the thallus rapidly aids in sending up a semi-hyaline slender branch which lasts barely long enough to allow the capsules to burst through their calyptræ and then withers away. By the time the spring botanist, roused from his hibernation, goes forth to search for Anemone or Epigæa, Conocephalus has long since scattered its spores, its fruiting branch is withered, and the late observer concludes that it rarely produces fruit. He who will become a botanist in any broad sense must come in contact with nature face to face at all seasons, and study plants as they grow, as well as in the herbarium and laboratory. The man who sees and studies plants *only* as they are represented by dried herbarium fragments or in accordance with the stereotyped formula, "treated with a one per cent. solution of chromic acid, stained in mass with picrocarmine, imbedded in paraffine and cut with a Minot microtome," is sure to get a one-sided notion of the true homologies of the vegetable world.

While all the minutiæ of the relations of the Marchantiales have not been worked out, the following provisional arrangement (see diagram opposite) will give some idea of their affinities.

From simple forms like Riccia, themselves doubtless a considerable advance over the primitive hepatic, we find slight modification in Ricciocarpus and Tesselina, and slightly more differentiated forms in Corsinia and Funicularia. To the former are allied such higher forms as Clevea, Aytonia and

Hypenantrum; from forms allied to the latter we have on the one hand Cyathodium and Targionia with their sessile fruit, and on the other, Lunularia, Conocephalus and Marchantia,



which justly may be regarded as the highest thalloid development that appears among the Hepaticæ.

II. *The Jungermaniales.* The second line of differentiation among the Hepaticæ is in the direction of the formation of a leafy axis. From such thalloid forms as Aneura with a scarcely developed central axis to such simple modifications as appear in Pallavicinia and Metzgeria, in which the central axis becomes distinctly differentiated from the plain wing-like border a single cell in thickness, it is an easy step to pass to such pseudofoliaceous forms as Schiffneria, Fossombronia and Haplomitrium. From these forms again it is not difficult to pass to some of the simpler leafy axes like Lophocolea, Bazzania, and Jungermania. It is in this group that we find the Hepaticæ attaining their greatest profusion of structure, the most remarkable diversity of foliar development, the widest range of adaptation, and the consequent abundance of genera and species that span the world from the lone and barren island of Kerguelen in the south to the inhospitable region of Spitzbergen in the north. Here some three thousand species have been developed, and judging from the rapidity of the returns, it is evident that the tale is not nearly told.

It is, of course, impossible, within the limits of the time assigned, to attempt to touch upon the numerous features of the evolution which this group has undergone in diverse quarters of the world; we can only hint at some of the more striking by way of illustration.

1. The protonemal development among the Jungermaniales is usually slight and ephemeral; in only occasional instances do we find it persistent. Perhaps the most striking illustration of this is Protocephalozia, in which the formation of leaves occurs only as a special development for the protection of the reproductive bodies. The antherids are borne singly in the axils of rudimentary leaves while the perianth, subtended by slender involucral leaves, rises directly from the original protonema which represents the entire vegetative condition of the plant.

2. The lines of development leading from thallose to leafy forms are numerous among the Jungermaniales, and all of them have not yet been definitely correlated. Certain it is that there is no single line of thallose genera as distinct from the foliaceous ones. While the greater part of the thallose forms do not produce their fruit terminally and hence may be separated into a distinct family which may be called the *Metzgeriaceæ* from its typical genus, there are several instances in which thallose forms lead up toward foliaceous forms with which they agree in the closer relation of sporogonial development, as well as in the more important fact that they bear

the sporogone terminal on the main stem or on a branch. The line of this character that is best known is perhaps that leading up to the Trigonantheæ from Zoopsis to Cephalozia. From the simplest thallose structure, differing only slightly from algæ, the various species of Zoopsis become developed so as to present the successive modifications of a leaf of a single cell, a leaf of two cells, and a leaf of four cells; from these steps the passage is easy to such simple two-toothed decurrent leaves as we see developed in some of the Cephalozias, especially in our common Cephalozia multiflora. The fruiting characters in this series are so strikingly alike that they have even been united in a single genus.

3. Perhaps no single group presents so many modifications in the diversity of foliar structure as is manifested in the various genera of the Jungermaniales. With nothing but leaf cells forming a more or less well developed lamina, the greatest conceivable variety of form coupled with modification arising from environment has been differentiated, and we find numerous examples of marvellous adaptation of means to end. From these we may note the simple tripartite leaves of Blepharostoma made up of simple rows of cells; the intricately divided leaves of Trichocolea and Ptilidium which give to the species of those genera their peculiar tomentose appearance; the ciliary fringes of endless variety that characterize the numerous species of Plagiochila; the median lamina of Schistocheila recalling a similiar development in Fissidens among the true mosses, and above all the innumerable paraphyllia of Stephaniella, often covering the entire surface of the leaf. These merely indicate a few of the possibilities of the foliar development. In the leaf cells themselves, we have every grade of compactness, varying from the lax structure of Cephalozia, Chiloscyphus and Kantia to the close compact structure of Herberta and Gymnomitrium.

But beyond all these are the various forms of complication of leaves clearly adapted to serve as retainers of moisture. From the simple folds in the leaves of Radula, Scapania and Diplophyllum, we pass to the basal pockets of Lejeunea which are sometimes elaborately differentiated, and the water sacs of Jubula, Frullania and more especially Polyotus in which they are sometimes developed in great profusion. As might be expected, these peculiar foliar adaptations for holding moisture most prominent in those species that have been driven from their normal habitat on the ground and on decaying logs to the bark of trees and even the surface of leaves, which in tropical countries are often wholly covered with various species of Lejeunea,[2] together with an occasional Radula and rarely species of other genera. The reputed symbiosis of rotifers and other small animals with these water sacs of Lejeunea and Frullania has been commented on by many observers.

4. No less remarkable is the development of the perianth which serves as a special protection to the maturing sporogone. This is normally free from the uppermost stem leaves, which are usually modified from the ordinary form. In certain genera like Nardia, Marsupella, Schistocheila and Harpanthus, the perianth becomes more or less adherent to the involucral leaves and in some instances forms a bulbous or gibbous enlargement at the base. An exaggeration of this bulbous development produces the marsupiocarpous condition found in Kantia, Geocalyx, Tylimanthus and several other genera, in which the sporogone is developed at the base of a pendulous pouch which penetrates the substratum, or in the tropical Tylimanthus is hung among the stems of various mosses which grow in its vicinity. It is of interest to note that this condition has been developed independently in widely different sections of the family and cannot be considered as forming a tribal alliance by itself as was formerly maintained.

It must now be evident that the Jungermaniales, above all other Hepaticæ, are the types in which the most elaborate development has taken place and that they must furnish the typical representatives of this class. When we add to the great degree of differentiation, the wide-spread geographic distribution of the Jungermaniales which has resulted in populating almost every available island in the world, frequently with endemic species, it becomes evident that we must attribute a great antiquity to the group. The comparative absence of the hepatics in fossiliferous rocks, for obvious reasons, should count as little in determining their antiquity.

III. *The Anthocerotales.* Having considered the two groups in which the hepatics have disported themselves as such, we

[2] I have only once found our Lejeunea calcarea in Indiana. In that instance it completely covered a small leaf of Camptosorus growing in the damp moss of a ravine. This is the first instance known to me of Lejeunea growing as an epiphyte in northern latitudes.

come finally to the group in which their development has looked toward something higher in the plant world. If the Marchantiales have elaborated the thallus at the expense of other parts, and the Jungermaniales have developed leafy axes and exhausted their energies in the elaboration of beauty and intricacy of foliar development, the Anthocerotales have found a more important line in which to differentiate, namely, the development of the sporogone. And while it has resulted in small returns when considered from a hepatic standpoint, the results otherwise are commensurate with the whole range of higher plants from mosses to Compositæ.

In the Anthocerotales, the thallus has undergone only a slight differentiation from the primitive type; the sporogone, however, develops into a fleshy structure that frequently requires stomata for its transpiration processes. The capsule is necessarily a somewhat permanent structure and unlike all other bryophytes, develops its spores continuously from above downward.

The ancestors of Anthoceros and Notothylas on the one hand, and the Musci on the other, were doubtless the same, and the line of separation between them probably commenced at an early day, since the elaboration of genera and species is no less marked in the Musci than in the foliaceous Hepaticæ.

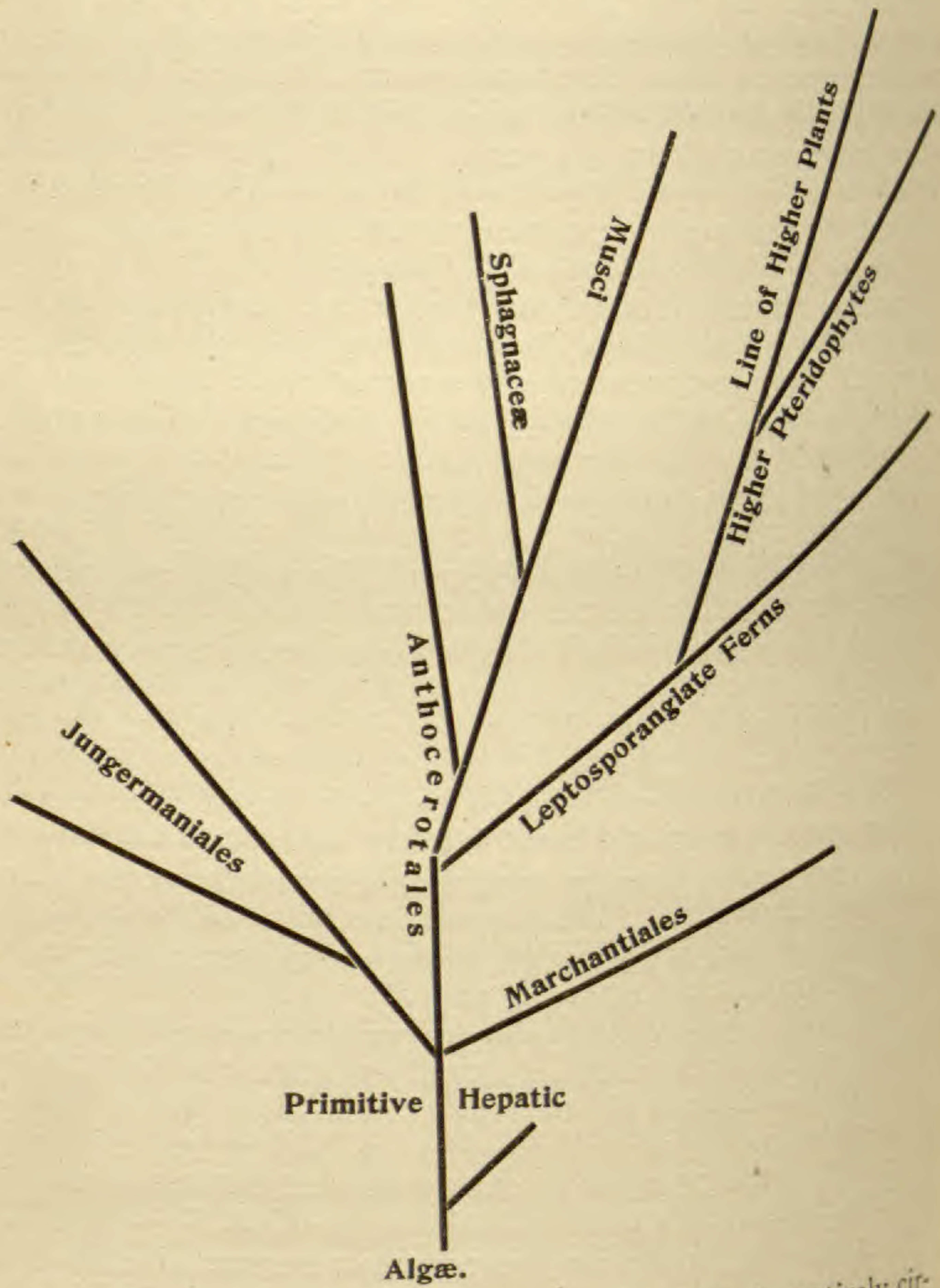
It has further become evident that the line of development of the leptosporangiate ferns, leading upward to the line of the higher plants, is to be sought as a branch from the primitive Anthocerotales. While more investigation is necessary in this direction, the general relations may be indicated by the diagram on the following page.

The early forms of Anthoceros were not swerved from their purpose; they have continued the development of the sporogone at the expense of the thallus and today stand unique among the Hepaticæ. They differ as widely from all other members of the group as do the Musci and Sphagnaceæ and, for this reason combined with others, the class Hepaticæ has little reason for further existence in our system of classification. A reorganization becomes necessary as soon as the remaining bryophytes can be properly co-ordinated.

We can then summarize the relations of the Hepaticæ.

1. The group is not of recent origin. This is shown not only from the wide-spread geographic distribution of its ma-

jor group, and its extensive modification into diverse genera, but as well by its relations through the Anthocerotales to higher groups which have themselves a high antiquity.



2. The group is not a compact one, nor is it entirely circumscribed. The three groups of the Hepaticæ above outlined differ as much or more among themselves as the remaining bryophytes differ from them. There is a necessity for a new grouping of the bryophytes to accord with our present

knowledge. The present grouping into Musci and Hepaticæ as coordinate classes, is entirely unsatisfactory, and artificial.

3. In such a triple development as exists among the Hepaticæ, no single plant can stand as a type which will fairly represent the entire group. If a single plant is to be considered, however, it would be only fair to make the selection from the group which is at once the most highly specialized structurally and the most widely represented in all parts of the world. To the Jungermaniales, and not to the Marchantiales, belongs this distinction.

4. We must recognize at least five families among the Hepaticæ. Among the Jungermaniaceæ, it is well to separate those forms in which the archegone terminates the growth of the shoot from those in which the archegone is distinctively a lateral development. The "Jungermaniaceæ anakrogynæ" of Leitgeb and Schiffner, which will include many but not all of the "Jungermaniaceæ thallosæ" of previous writers, may well be separated as a distinct family for which we propose the name METZGERIACEÆ. The older name, Jungermaniaceæ, may properly be retained for the remaining part of the family which includes by far the greater number of genera and species.

5. The Hepaticæ are especially interesting as constituting the connecting link in the evolution from thallophytes (algæ) to the higher plants. In this particular, the line of the Anthocerotales in which mere vegetative function is sacrificed for the sake of reproductive function, represents the royal line of development.

De Pauw University, Greencastle, Ind.

Proceedings of section G, A. A. A. S., Brooklyn meeting, 1894.

THURSDAY, AUGUST 16TH.

Section G met at 11:15 A. M., and organized by electing as councilor, Byron D. Halsted; as members of sectional committee, in addition to the ex officio members, Geo. F. Atkinson, W. J. Beal, B. T. Galloway; as member of nominating committee, A. B. Seymour; as committee to nominate officers of section, the officers and John M. Coulter, M. B. Waite, and J. J. Davis.

At the suggestion of the council a new officer, to prepare for the press readable reports of papers presented, was appointed. Byron D. Halsted was elected "press secretary."

At 4:30 P. M., vice-president Underwood's address (printed in full elsewhere) was read by Dr. S. E. Jeliffe.

MONDAY, AUGUST 20TH.

Reports from the standing committees appointed by the Madison Botanical Congress were called for.

The Committee on Bibliography and Typography presented the following report:

To section G, A. A. A. S.:

The Committee on Bibliography and Typography appointed by the Madison Botanical Congress was directed to report to section G of the American Association for the Advancement of Science. This section therefore is asked to receive the following report and take such action thereupon as seems wise:

The committee report that progress has been made during the past year in carrying out the suggestions made to the Madison Botanical Congress.[1] The first recommendation thereto made, viz., "that there should be published . . . by a catalogue of papers [relating to American botany] by authors," has been undertaken and so far as it has gone has been successfully accomplished by the cooperation of a number of botanists with the editors of the *Bulletin* of the Torrey Botanical Club and the Cambridge Botanical Supply Co. This index, printed first in the *Bulletin*, is reprinted upon standard cards by the Cambridge Botanical Supply Co., so

[1]Proc. Madison Bot. Congress 45. Je 1894.

that any number of copies can be had and arranged by subjects or by journals as desired. Every effort will be made by those charged with the preparation of this index and its first publication to make it complete, and to have it conform exactly to the rules for citation prepared by this committee. The work of publication upon cards, however, is not adequately supported. The committee sincerely hope that this form of publication will not have to be given up, and they therefore urge that those interested testify their interest by sending their subscriptions to the Cambridge Botanical Supply Co., Cambridge, Mass.

The committee also announce that the BOTANICAL GAZETTE, in connection with the Cambridge Botanical Supply Co., is ready to undertake the publication of the supplementary list of journals referred to in section 1. *b.* of the committee's report[2] to the Congress which appointed it. The publication of these lists of journals upon cards will be begun as soon as subscribers sufficient to defray the expense of printing the cards can be secured. In the same way the *Bulletin* of the Torrey Botanical Club will undertake the publication of the list of authors referred to in the committee's report under 1. *c.* If the number of subscribers to the index of papers above mentioned as in course of publication can be immediately increased, these author and journal cards will, for the present year, be sent free to subscribers.

The committee again call attention to the index of new genera and species of plants now being issued on cards by Miss Josephine A. Clark, of Washington, D. C., and commend this to the support of botanists. Regarding this private publication they beg to suggest (1) that there be added to these cards such marks as will serve to identify the series when distributed in other indexes; (2) that in the interest of completeness *all* new names relating to North American plants be included.

A year's experience in the working of the rules for citation approved by the Madison Congress has not shown the necessity or desirability of any changes. To those rules, however, the committee desire to add the following amplification:

In *f*, p. 46, l. c., before the last sentence insert: In case the original paging is unknown an em dash should occupy

[2] Loc. cit.

its place, the reprint paging being given in accordance with the foregoing rule.

The committee also recommend the adoption of the two following paragraphs as addenda:

j. If it is considered desirable to give other data than series number (if any), volume number, page and date, these should be added in brackets after the date. But useless or unnecessary data should be avoided.

k. Citations of reviews, abstracts, and all such secondary references should be enclosed in parentheses.

Since uniformity is the chief object in the adoption of the rules for citation by the Congress, the committee call attention to the necessity of an exact following of these rules by as many writers and publishers as can be induced to give adhesion to them. To facilitate this we recommend that the editors of the *Bulletin* of the Torrey Botanical Club, the *Botanical Gazette*, *Erythea*, and the *American Naturalist* be requested to publish these rules, and examples of as great a variety of citations as practicable. The committee also desire to issue these on tag-board sheets, in a form which can be readily distributed and preserved for convenient reference. To enable the committee to do this, and to disseminate information upon these points, we recommend that the Council of the A. A. A. S. be requested to make a grant of $25 to cover the necessary expenses which may be incurred.

C. R. BARNES,
A. B. SEYMOUR,
L. L. BRITTON,
for the Committee.

The report was accepted and adopted, and the committee continued.

The grant asked for was voted by the Council of the A. A. A. S. at its meeting on Tuesday morning. The committee will therefore have printed shortly the rules for citations, with examples, in large type upon tag-board, and mail copies to all desiring them. Application should be made to the Cambridge Botanical Supply Co., Cambridge, Mass.

The Committee on the Terminology of Physiology was called. In the absence of the chairman, Dr. J. C. Arthur, Dr. Barnes reported that so far as he was aware, the committee had done nothing. The committee was continued with instructions by the Section to prosecute its work.

The Committee on the Terminology of Anatomy and Morphology was called. No report was ready. In the absence of the chairman, Prof. Conway MacMillan, it was suggested that the committee be continued with instructions to present a report next year, since suggestions by this committee are desired to secure as great uniformity as possible in the terminology of the new Systematic Botany of North America.

The Committee on Geographical Botany reported that its work was in progress and that a full report would be rendered next year. The committee recommended that two additional members, Dr. N. L. Britton, selected by the committee, and one to be named by the vice-president of the Section, be appointed. The report was accepted and adopted, and the committee continued.

The Committee on the Nomenclature of Plant Diseases was called. The chairman, Dr. B. D. Halsted, announced that a report would be ready on Tuesday.

In joint session of Sections F and G the following resolutions of the Committee of the A. A. A. S. on a table at the Marine Biological Laboratory at Woods Holl, Mass., were offered by Dr. S. H. Gage for adoption by the Sections:

The Sections of Zoology and Botany (F and G) request that the Association continue its subscription of $100 for an investigators' table at the Marine Biological Laboratory at Woods Holl, Mass.

The two sections in joint session also make the following suggestions for the award and government of the table subscribed for by the Association:

1. That the table shall be known as the A. A. A. S. table.

2. That the award of this table shall be entrusted to a committee of five, consisting of the vice-president and secretary elect of each Section (F and G), and of the director of the Marine Biological Laboratory (at present C. O. Whitman).

3. Any fellow or member of the A. A. A. S. shall be eligible for appointment to the table. (An applicant for membership in the Association will be considered as a member and therefore eligible.)

4. Applications for the table are to be made to the permanent secretary, who shall forward them to the senior vice-president of Sections F and G, seniority being determined as in §11 of the Constitution, i. e., according to continuous membership.

5. That the holders of the Association's table are expected to give proper credit for the use of the table in all published results of investigations carried on at the table.

The resolutions were adopted. At a meeting of the Council in the evening the subscription was continued for 1895 and the above regulations for its use adopted.

TUESDAY, AUGUST 21ST.

The Committee on the Nomenclature of Plant Diseases presented the following report, which was accepted and adopted, and the committee continued.

To Section G of the American Association for the Advancement of Science:

The Committee upon the Nomenclature of Plant Diseases, appointed by the Madison Botanical Congress, by vote of that body begs to make the following report:

The committee finds itself with a somewhat difficult task upon its hands. Names of fungous diseases that are now in general use it will be difficult, if not impossible, to uproot and set aside. Thus the black rot of the grape and black knot of plum and cherry are well known, distinctive and fixed. In an ideal nomenclatural system there would be distinctive common names for the various groups. This in a measure has been accomplished, for we have downy mildews for Peronosporeæ, rusts for Uredineæ, and smuts for Ustilagineæ. There is a vast number of species of the large genera like Septoria, Phyllosticta, Cercospora, Ramularia, etc., that are not easily given general names. Thus a Septoria or Phyllosticta may produce a definite spot upon the leaf or affect the whole area and the term "leaf spot" is inappropriate. It is possible, for example, for blights (pear), rots (hyacinth), wilts (melon), tuberculosis (olive), and other diseases to be produced by bacteria. It is suggested that when possible the term bacteriosis be used for such cases. This can be done when a mycologist has the opportunity to set forth the disease before the world, and antedate any name or names, for there may be many, that arise among the people.

Anthracnose is a name that is used so generally that it has very little significance. It should, like many others, be restricted.

Without further argument the principal points which the committee would respectfully present for your consideration are as follows:

(1) When a good name has become firmly established no effort should now be made to change it, except when it is manifestly inappropriate, as the so-called "strawberry rust" and "celery rust."

(2) There should be terms to distinguish between the parasite and the disease it produces. It is awkward to say "this disease is *rust*, and it is produced by a *rust*." An improvement upon this would be to state that this disease is uredinosis, and is produced by a rust, giving the botanical name of the rust or even the genus when possible.

(3) The diseases need to have, for popular use, English or at least Anglicised names, and these may well be derived from those already in use.

(4) Names should be as far as possible descriptive, and indicate the plant attacked; therefore more than one word will usually be required, as "peach leaf-curl," the last two words being hyphened. There will be many cases where the name of the host can be coupled with the genus of the parasite, thus giving a substantial compound name, as potato-macrosporium or bean-colletotrichum.

(5) After the pathology of plant diseases is understood much better than now a scientific classification of them can be made, and appropriate names given to each; at present only an artificial system can be hoped for.

A tentative classification and nomenclature may be made in various ways, as, e. g.:

(*a*) from the group names of the parasites as the
Uredineæ producing uredinosis
Bacteria " bacteriosis
Ustilagineæ " ustilaginosis

(*b*) from the gross effect upon the host as rot, scab, spot, blight, rust, smut, club-root, black-knot, mold, gall, damping off, etc., for which Latinized names might be constructed, and

(*c*) from the general cause of the disease; (1) unfavorable habitat, (2) unfavorable atmospheric conditions, (3) mechanical injuries. (4) parasitism, (5) teratogeny.

(6) From what has been presented above it is clear that the results obtained by the Committee are far from final and therefore it is suggested that the work be continued and that it be along the following among other lines:

(*a*) Collate and tabulate the common names of plant diseases now in use.

(*b*) Construct a working scheme in which every plant disease is assigned a place with a distinctive (scientific) name followed by an English name, the last to be, when possible, the one already in use.

(*c*) It is recommended that the parasite should be distinguished from the disease in all cases.

(*d*) It goes without saying that mycologists are urged to apply names to plant diseases instead of leaving the matter of a choice to a popular verdict.

BYRON D. HALSTED,
B. T. GALLOWAY,
GEO. F. ATKINSON,
CHARLES E. BESSEY,
for the Committee.

At the suggestion of the Council, the section appointed special committee to make arrangements for the next meeting, 1895. The committee consists of the vice-president and secretary elect and the sectional committee of the 1894 meeting.

The nominating committee selected for vice-president 1895, Dr. J. C. Arthur, Prof. of Botany, Purdue University, Lafayette, Ind., and for secretary, Mr. B. T. Galloway, Chief of the Division of Vegetable Pathology, Washington, D. C. They were elected in general session, Tuesday.

Papers read before section G, A. A. A. S., Brooklyn meeting, 1894.

GALLOWAY, B. T.: *The growth of radishes as affected by the size and weight of the seed.*—The relation of the weight of the seed to the weight of the products was considered, and the physiological questions involved discussed. It was shown that by using large seed about 90 per cent. of the crop reaches marketable size at the same time. Where mixed seed are used, or seed as it usually comes from the market, from 45 to 50 per cent. only of the crop matures at the same time. In other words, by using large seed 90 per cent. of the crop will mature in from thirty-five to forty days, and where large and small seed are used about 50 per cent. of the crop will mature in the same time.

GOLDEN, KATHERINE E.: *Movement of gases in rhizomes.*—Rhizomes are usually transversely geotropic organs, having stored in them elaborated food. Their epidermis is free from stomata and lenticels, so that the gas found in them can enter through the epidermis only, the tissue absorbing it from the surrounding air. The rhizomes used in the experiments were those of Mentha piperita, Helianthus grosse-serratus, Solanum tuberosum, and Mimulus moschatus, the epidermis of all being unlignified and unsuberized, the outer wall thickened and the cells packed so closely together as to form an imperforate membrane. The inner tissue was made up nearly entirely of parenchyma, having large intercellular spaces through which gases, after gaining access to the interior, could very readily permeate.

1. In the majority of rhizomes examined the contained gases were under greater pressure than the atmosphere, an interval of twenty to twenty-five minutes being required for the pressure of the gases in 1^{mm} of the rhizomes to become the same as the pressure of the atmosphere. The method of procedure was to space off rhizomes into definite lengths, the rhizomes being then placed under water and cut at varying intervals of time, the bubbles of gas, as they rose through the water, being easily seen. The next point determined was the rate of passage of gases through definite lengths of rhizomes that were fastened in tubes filled with mercury. The

descent of the mercury in the tubes showed the rapidity of the passage of the gas. Gas passed through rhizomes very rapidly for the first hour, though becoming slower towards the end of the hour, and finally, as the rhizomes became saturated with the gas, becoming so slow as to take some times a day for the mercury in the tube to come to the level of that outside. The gas passed more rapidly through short than long lengths of rhizomes.

2. To determine passage of gas through sections of epidermis under pressure, sections of epidermis were fastened on the end of a glass tube, which was then filled with mercury and placed in a vertical position in a vessel of mercury. The mercury remained at its original height for days, though the sections would become concave from the pressure on them.

3. To determine amount of diffusion of gases without pressure through living plant membranes and dead plant and animal membranes, sections of hog's bladder and living and dead epidermis were fastened on tubes as before, the tubes being filled with water instead of mercury, the water then being displaced by the gas. The sections permitted considerable diffusion to take place, though the greater amount was attained by the living plant membrane.

4. To determine rate and amount of diffusion of gases through both epidermis and internal air cavities, lengths of rhizomes were fastened air-tight into tubes, the end of the rhizomes extending into the tube being sealed. The tubes were then filled with gas as before, carbon dioxide, hydrogen, and ammonia being used. The ammonia killed the plants so that no comparison between it and the other gases could be made. The carbon dioxide showed greater rapidity and amount of diffusion, and was uniform in diffusing, whereas the hydrogen was subject to fluctuations, the mercury in the tube sometimes dropping to the level of that outside. Both gases diffused more rapidly when the temperature was low, the high temperature very probably causing the gas to exert sufficient pressure to hinder diffusion. The individual plant was the factor of greatest importance, as like plants under similar conditions showed variations in the rate and amount of diffusion.

BEAL, WM. J.: *The sugar maples of Central Michigan.*—Descriptions of A. barbatum and the var. nigrum were given. It was shown that *A. saccharum barbatum* Trelease is not even a variety, as it is found growing on the tops of numerous trees of the species. A summary of comparisons of *A. barbatum* and *A. barbatum nigrum* was given. It was shown that color of branches and stems, shape of top, number of leaf lobes, depth of sinus, leaf-texture, could none of them be used as diagnostic characters. Intermediate forms between the species and variety were also noted and the author inclined to the conclusion that the varietal rank of A. barbatum nigrum is reasonably established.

COULTER, JOHN M.: *Some affinities among Cactaceæ.*—A study of our species of *Cactus* (Mamillaria), *Anhalonium*, and *Lophophora* has suggested certain lines of genetic affinity, indicated by the relative position and structure of the tubercles, spines and flowers. In the discussion the two subgenera of Cactus (Eumamillaria and Coryphantha) were considered separately. Eumamillaria is characterized by its grooveless tubercle, which bears at its summit the spine-bearing areola, and in its axil the flower-bearing areola. Coryphantha shows the same relative position of the two areolæ but they are connected by a deep woolly groove running down the upper face of the tubercle; in fact, the two areolæ seem to be but expansions of the groove at its extremities. In *Echinocactus* the two areolæ become contiguous at the summit of the tubercle. The relation between Echinocactus and Coryphantha is made evident by intermediate forms, in which the groove gradually shortens, making the flower areola more and more extra-axillary, so that it gradually ascends the tubercle, until reaching its summit and becoming contiguous with the spiniferous areola, the resulting form is an Echinocactus. Whether the groove has gradually shortened or lengthened is not clear, but the indications are that the Echinocactus condition has given rise to Coryphantha, and that, in turn, by the closing of the groove, to Eumamillaria. Related to these forms are two aberrant genera, now regarded as such, but frequently variously referred to Cactus (Mamillaria) and Echinocactus, viz: Anhalonium and Lophophora. The real affinities of these two genera are indicated upon an examination of their growth. The very young tubercles of Anhalonium are those of Coryphantha, such as those of Cactus macromeris, with the floriferous areola extra-axillary, the woolly groove extending about half way down the tubercle. In later development, however, the upper and lower portions of the tubercle become much modified and very different from each other, the upper portion becoming a very thick triangular bract, in some cases preserving the woolly groove, in other cases the groove being obliterated and appearing only as a minute tuft at the tip. In all cases the spiniferous areola is completely obliterated. It seems evident that Anhalonium is an offshoot from forms intermediate between Echinocactus and Coryphantha.

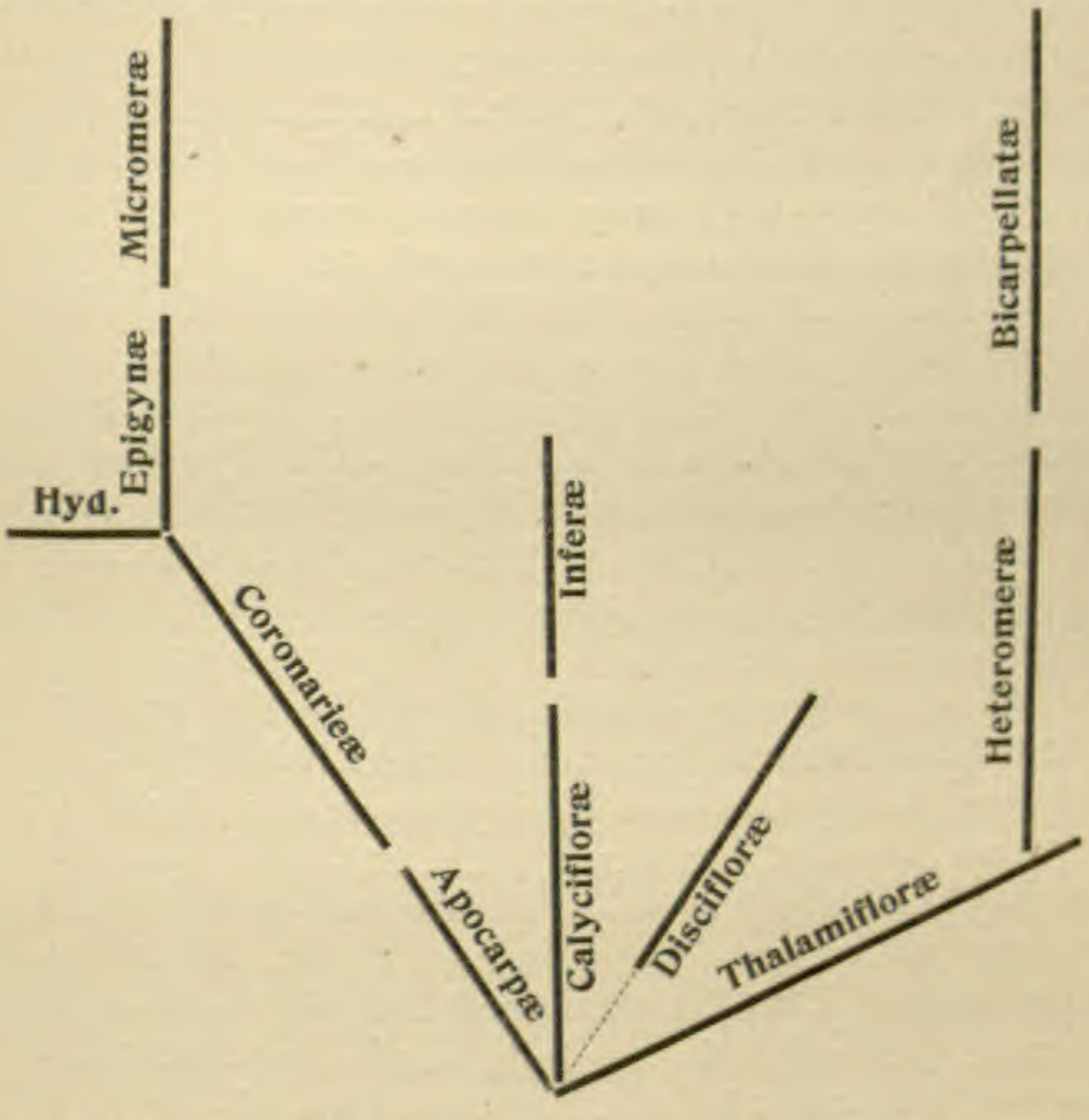
Lophophora has been still more puzzling, as it shows a grooveless tubercle, upon the summit of which is the floriferous areola, suggesting at once Echinocactus, to which the forms have mostly been referred. However, the entire disappearance of a spiniferous areola should suggest doubt. The very young tubercle of Lophophora shows the floriferous areola below the summit, but the small tip develops no further, while the floriferous areola becomes terminal by the large development of the lower portion of the tubercle into a broad mass, in the center of which the floriferous areola appears as a small depression with a penicellate tuft of hairs.

In conclusion, in the group of forms under consideration, Echinocactus is suggested as the primitive one, with its grooveless tubercles bearing at summit the contiguous areolæ. The formation of a groove separating these slightly at first, and finally carrying the floriferous areola to the axil of the tubercle, has given rise to Coryphantha, intermediate forms having given rise to the aberrant genera Anhalonium and Lophophora; while the closing of the Coryphantha groove has given rise to Eumamillaria. It may be that this evolution has proceeded in the opposite direction, from Eumamillaria to Echinocactus, but it would not change the relative position of the genera here suggested.

BESSEY, CHARLES E.: *Simplification and degeneration of structure in the angiosperms.*—The speaker emphasized the thought that evolution proceeds in the direction of increasing simplification as well as of increasing complexity. The Umbelliferæ and Compositæ were used as illustrations of groups of high rank in which there has been a simplification of the floral parts. This is not to be confused with real degeneration, such as occurs in dodder and mistleto.

NEWCOMBE, F. C.: *Regulatory growth of mechanical tissue.*—To be published in full in this journal.

BESSEY, C. E.: *Further studies in the relationship and arrangement of the families of flowering plants.*—The paper presented a brief discussion of the primitive flower of the monocotyledons; modifications of the primitive flower by increased complexity of structure; the origin of sedges and grasses; development of irises and orchids; the primitive flower of the dicotyledons; modifications by increased complexity; modifications by simplification; development of the Bicarpellatæ and of the Inferæ. It was accompanied by the following chart of suggested changes in the arrangement of groups in accordance with genetic lines.



SMITH, ERWIN F.: *The watermelon disease of the South.* —This is a disease of the vine of hitherto unknown origin, widely prevalent in the melon districts of the southeastern United States and so destructive that growers in Georgia believe that it is impossible to raise melons in the same field two years in succession, or oftener, with profit, than once in 5 to 7 years. In some districts in Georgia and South Carolina the disease has this year reduced shipments one-third to one-half, and in the worst cases has taken the whole crop of individual growers.

Large vines in full vigor wilt suddenly, without apparent cause. This is followed in a few days by the death of the vine, but during this period there are no external indications of parasites, either above ground or below. The cortex is turgid, free from spotting, and normal in color at the time the leaves begin to wilt.

Constantly associated with the earliest stage is a fungus apparently undescribed and to which I have given the provisional name, *Fusarium niveum*. It occurs in the ducts of the stem, filling them more or less completely and interfering with the movement of water from roots to foliage. The fungus was most abundant near the crown, but it was found in many parts of the root system and in the vessels of the stem abundantly as far as 0.5–1.5^{m} away from the roots.

This fungus gains entrance through the root system, and there are some indications that this infection takes place principally within the first few weeks after planting. At that time all the tissues are attacked, in hot wet weather damping off the seedlings as energetically as a Pythium. Later the parenchyma becomes more resistant, and the fungus betakes itself to the bundles, and especially to the ducts, but when the stem begins to shrivel it is again found invading the parenchyma.

Conidia are produced abundantly within the vessels of the vine and pure cultures have been made from these.

The most badly attacked fields observed in South Carolina were those heavily fertilized with barnyard manure made from what is locally known as "watermelon hay," i. e., wild grass, cut in autumn from melon fields, including many blighted vines. This is composted and put back on the fields at time of planting. In my judgment a modification of the method of manuring, a judicious rotation of crops, and the prompt destruction of diseased vines would do much to lessen the prevalence of this disease.

ATKINSON, GEO. F.: *Preliminary note on the relation between the sterile and fertile leaves of Onoclea.*—The complete differentiation between the fertile and sterile leaves of *Onoclea sensibilis* suggested that the so-called var. *obtusilobata*, which is an intermediate state, could be artificially induced by amputating the early vegetative leaves of this fern. The leaves were then cut from a patch of this fern on May 11th, June 9th, and July 12th, respectively. On July 12th, a few leaves were seen which showed the transition stages. On August 8th and 9th the plants were gathered and every conceivable gradation between the fertile and sterile leaves was present, as illustrated in over thirty specimens. Some leaves of the fertile kind were expanded to a size equal to that of large sterile leaves, but usually the venation was coarser and a few rudimentary indusia could usually be found on the basal pinnules of the lower pinnæ. Some leaves were found which it was impossible to properly correlate. The number and perfection of the sporangia as well as the indusia varied in accordance with the variation of the leaves. On those leaves or parts of leaves where but few or rudimentary sporangia were developed, there were frequently cases of apospory, rudimentary prothallia being developed from the placental region.

RUSBY, H. H.: *Lophopappus, a new genus of mutisiaceous Compositæ, and Fluckigeria, a new genus of Gesneriaceæ.*—The author gave the general characters of the groups to which the new genera belong, their positions in such groups, the occurrence of the plants on which the new genera are based, and the description of the latter.

ATKINSON, GEO. F: *Preliminary note on the swarm spores of Pythium and Ceratiomyxa.*—Recent study of the "damping off" fungus from fern prothallia and green house cuttings of dicotyledons has served to show that considerable confusion exists concerning our knowledge of the swarm spores of the genus *Pythium*, or that the genus is a very heterogeneous one. In DeBary's[1] earlier work he says that *P. proliferum* possesses oval uniciliate zoospores, and that occasionally double zoospores made their escape before they were completely formed. These possessed two cilia and later divided into uniciliate zoospores. *P. reptans*[2] on the other hand has biciliate zoospores, which are reniform, and the cilia on one side not far from the end. Without division these rounded off and germinated. In the later work[3] he places *Pythium* in the Peronosporaceæ and says the members of the family possess swarm spores with twolateral cilia. Schrœter[4] characterises the swarm spores of his family Pythiaceæ as being reniform

[1] Einige neue Saprolegnieen. Prings. Jahrb. f. wiss. Bot. **2:** 185. 1860.
[2] Ibid. p. 187-8.
[3] Beitr. z. Morph. u. Phys d. Pilze **4:** 93. 1881.
[4] Engler u. Prantl's Natürlich. Pflanzenfam. **1:** —. —.

with two lateral cilia, and yet introduces Hesse's figure of *P. DeBaryanum* with oval uniciliate zoospores.

According to Pringsheim,[5] *P. entophytum* has uniciliate zoospores. *P. cystosiphon* Lindstedt *(Cystosiphon pythioides* R. & C.), according to Roze and Cornu[6], has reniform swarm spores, the two cilia arising from the pointed ends instead of from the side. *P. Equiseti* Sadebeck,[7] which DeBary[8] places as a synonym of *P. DeBaryanum*, has swarm spores exactly like those of *P. cystosiphon*. *P. DeBaryanum* Hesse, as indicated above, has, according to its author, oval uniciliate swarm spores.

The Pythium which I have studied from the botanical conservatories of Cornell University is what I have supposed to be the *P. DeBaryanum* Hesse, and is probably what usually passes for that fungus in America. The peculiarities which I have observed are as follows: The swarm spores in process of formation are reniform with rounded ends, the developing cilia issuing from the broadly rounded ends, which because of the form of the body are turned to one side. On issuing from the swarm-sporangium they are long reniform with pointed ends and a cilium is attached to each end directly at the point. After swarming for a while amœboid movements ensue without the loss of the cilia. Soon a constriction appears and eventually the swarm spore divides into two oval uniciliate swarm spores. These swarm again and eventually come to rest and germinate. The questions arise whether these discrepancies are due to imperfect observations on the part of some, or whether there are specific differences according to the character of the zoospores, or whether all are at first biciliate, becoming later uniciliate, or whether there is great variation in the different species in this respect, so that at one time both kinds of zoospores will be developed and at another time only one kind. These questions I shall not attempt at this time to answer.

In studying the germination of the spores of a species of *Ceratiomyxa* Schrœter[9] *(Ceratium* A. et S.), a form was used

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[5]Prings. Jahrb. f. wiss. Bot. **1**: 289. 1859.
[6]Sur deux nouveaux types génériques pour les familles des Saprolégniées et des Péronosporées. Ann. d. Sci. Nat. Bot. V. **11**: 78. 1869.
[7]Unters ü. Pythium Equiseti. Cohn's Beiträge z. Biologie d. Pflanzen **1**: 121. 1875.
[8]Zur Kenntniss der Peronosporeen. Bot. Zeit. **39**: 528. 1881.
[9]Engler u. Prantl's Natürlich. Pflanzenfam. **1**: 16. —.

which may be the type of a new species to be known as *C. plumosa.* The sporophores possess a stout base but are very profusely and finely branched, very much more so than *C. mucida* (P.) Schrœt., and have been chiefly found on rotting elm and basswood stumps or logs. Spores freshly matured and sown in pure water before drying germinated within two to six hours.

The germination differs from that of any other genus of the Myxomycetes. Through a small perforation in the wall of the spore the protoplasm escapes slowly as a vermiform body which possesses tortuous motions and slight amœboid movement of the surface. In the course of fifteen minutes to one hour this shortens and becomes amœbiform, the developing pseudopodia being quite short and slender but longer than those on the vermiform body. Four rather clear spaces appear in the protoplasm which precede the simultaneous parti-division of the mass into a four-lobed body. These then farther divide once forming an eight-lobed body; minute pseudopodia developing the meantime over the surface of all the lobes. A single long cilium is now developed from the end of each lobe and quite violent lashings follow accompanied by the continued development of the pseudopodia.

The individual lobes separate frequently in pairs which remain for a time in communication but eventually separate. Sometimes three to six may remain joined for several hours assuming various shapes, but always showing the individual lobes and the long cilium. These frequently simulate the form of a star fish.

Famintzin and Woronin[10] have studied the germination of the spores of *Ceratiomyxa mucida* (P.) Schrœt. *(Ceratium hydnoides* A. & S.) and their account differs somewhat from that which I have observed. In the first place they were not able to germinate the spores until after they had passed a period of drying, and then only in a nutrient medium formed by a solution of rotten pine wood in water. They were not able to induce germination in water alone. The spores germinated only after about thirty hours from the time of sowing. On germination there was no vermiform body but the amœboid form issued directly, and division began by bi-partidivision instead of quadro-parti-division and continued up to the eight-lobed body when they separated in pairs.

[10] Ueber zwei neue formen von Schleimpilzen: Ceratium hydnoides A. et S., u. C. porioides A. et S. Mém. d. l' Acad. Imp. d. Sci. d. St. Petersbourg, **20**: –. 1873. [No. 3.]

It is difficult to believe that specific differences would account for the differences in the observations, nor can we suppose that Famintzin and Woronin overlooked the vermiform body in the first stage of germination. Probably there may be some variation in individuals in this respect.

BRITTON, ELIZABETH G.: *A revision of the genus Scouleria.*—The author described the type of the genus, *Scouleria aquatica*, and reduced *S. Nevii* Kindb. and *S. Muelleri* Kindb. to it. *S. marginata* was described as a new species. The paper was illustrated by drawings and specimens.

WILDER, BURT G.: *Evidence as to the former existence of large trees on Nantucket Island.*—Fragments of large trees have been found while cutting peat at Polpis, Hughes' Neck, and the author saw in this bog a stump 1.75^{m} in circumference. Near by as many as twenty stumps of various sizes were found.

BRITTON, N. L.: *Notes on the primary foliage and leaf-scars in Pinus rigida.*—The author exhibited twigs and old bark of this pine and discussed the foliar morphology, suggesting the possible affinity of some fossil plants commonly grouped with pteridophytes with the pines. The resemblance between the primary leaf-scars and those on the stems of lepidodendrids is certainly striking.

HALSTED, BYRON D.: *Notes on Chalara paradoxa.*—The fungus *Chalara paradoxa* (De Seynes) Sacc. is recorded in Saccardo's Sylloge Fungorum. The writer studied it during the present year as growing upon pineapples. It furnishes the best material thus far met with for illustrating the internal abjunction of spores. When the time arrives for the production of these spores, the tip of the hypha dissolves and the protoplasmic contents become divided serially into a row of hyaline cylindrical spores which are pushed out of the tip of the spore-bearing hypha. While the process of spore formation is at its height the time for the deliverance of a spore may not exceed fifteen minutes.

There is a second form of spore much larger than those above described, that forms in the ordinary way and, not separating readily, produces long necklace chains. There is a third form of spore midway between the two sorts mentioned in that it is produced by internal abjunction but is brown and oval and not hyaline. This is likely a variation due to conditions under which the spores are produced. There are also spores produced within the substance of the host (pineapple flesh) that are still different.

BRITTON, ELIZABETH G.: *A hybrid among the mosses.*—Definite record of hybrids among some species of mosses have been made in Europe. The author here makes the first American record of such a hybrid. The parents are *Aphanorhegma serrata* ♀ × *Physcomitrium turbinatum* ♂ (?). The specimens were distributed as *Schistidium serratum* in Drummond's Southern Mosses no. 20. They show both the normal fruit of one of the parents and the hybrid capsules, growing together from the same stem.

HALSTED, BYRON D.: *Notes upon a root-rot of beet.*—During the present year a serious fungous decay was found upon the roots of field and garden beets. It seems to be an undescribed species of the genus Phyllosticta. The present paper describes the rapid and profuse development of the pycnidia of this fungus upon the cut surface of the affected parts of the beets; the complete separation of the pycnidia by the intervention of a layer of thin cloth laid upon the freshly cut surface; and the confirmation of previous statements regarding the non-sexual origin of the pycnidia.

BRITTON, N. L.: *On Torreya as a generic name.*—As an evidence that the law of homonyms is necessary for stability of nomenclature, the case of Torreya was presented, a generic name which has been applied six times. The record is as follows:

Torreya Raf. (1818) = *Synandra* Nutt. (1818).
Torreya Raf. (1819) = *Pycreus* Beauv. (1807).
Torreya Spreng. (1821) = *Ægiphila* Jacq. (1774).
Torreya Eaton (1833) = *Mentzelia* L. (1753).
Torreya Arnott (1838) = *Tumion* Raf. (1840).
Torreya Croom (1843) = *Croomia* Torr. (1840).

The only one of these genera that has stood has been the Florida taxoid tree of Arnott.

BRITTON, ELIZABETH G.: *Some notes on the genus Encalypta.*—The author compared the European and American specimens of *E. ciliata*, with some notes on *E. longipes* and *E. Macounii.*

HOTCHKISS, JED.: *The growth of forest trees illustrated from marked corners 107 years old.*—Specimens illustrating marks on corner and line trees taken from the Henry Banks

10,980 acre patent, in Greenbrier co., W. Va., surveyed April 18, 1787, were shown. The growth varied from .03 to .05^{in} per year, and the number of growth layers agreed in number exactly with the record.

PATTERSON, MRS. F. W.: *Species of Taphrina parasitic on Populus.*—American mycologists formerly referred to *Taphrina aurea* specimens occurring on ovaries of *Populus tremuloides* and other hosts. It has been shown, however, that the name T. aurea belongs only to the form on leaves, which has not been known heretofore in America. The form on ovaries was then supposed to be identical with Johanson's *T. rhizophora* but from this it now proves to be quite distinct and easily recognized by size of asci as belonging to *T. Johansonii* Sadebeck. A form differing but slightly from T. aurea has now been found also in Iowa, parasitic of several species of Populus planted from Europe.

The following papers were presented in joint sessions of Sections F and G:

BUTLER, A. W.: *Work of the Indiana biological survey.*—An account of the organization of this work by the Indiana Academy of Sciences, its plan and progress.

HOPKINS, A. D.: *Some interesting conditions in wood resulting from the attacks of insects and woodpeckers.*—The author described the modes of attack by which wounds involving twisted grain and various discolorations were brought about. It was stated that the curly or "bird's-eye" grain of poplar was due to the persistent wounds made by the downy woodpecker, and the same cause was suggested for the bird's-eye maple. Further investigations are in progress.

BAILEY, L. H.: *Relation of age of type to variability.*—1. There is a wide difference in variability in cultivated plants. Some species vary enormously. The type of lettuce, cultivated for somewhat less than 2,000 years, was early lost and the cultivated species was named *Lactuca sativa* but it is really the *L. Scariola.* The type of soja bean and of the sweet potato are not known. Of tomatoes the cultivated varieties are more removed from the type than many species are from each other.

2. Variability is not due to age, cultivation, nor geographical distribution.

3. Variability under cultivation is due to some elasticity of the species and is thus inherent.

4. The newer the type the more readily it varies. New types are polymorphous, old types are monomorphous. The most flexible types have not yet passed their zenith, e. g., Cucurbitaceæ. The varieties of cereals are so much alike that expert knowledge is needed to distinguish them.

5. Why are new types flexible? A certain answer cannot be given but the author believes it explicable on the principle of divergence of characters rather than by any rejuvenescence of type.

BAILEY, L. H.: *The struggle for existence under cultivation.*—The struggle for existence under cultivation can be resolved into figures. Seedsmen estimate that one-fourth the seed produced is lost because unsown. (But this is less than nature wastes among wild plants.) Three-fourths therefore engage in the struggle for existence. Only one in thirty or one in twenty of these come to anything. The rest are thinned out. This is a struggle between members of the same species; therefore the struggle sets up a divergence within the species. Added to this is the selective agency of the weeder. The same laws which govern evolution in feral conditions govern evolution under cultivation.

MILES, MANLY: *Limits of biological experiments.*—The author contended that evolutionary laws cannot be demonstrated by direct experiment because of the great number of uncontrollable factors, a point well illustrated by the many valueless feeding experiments.

Titles of informal papers and notes presented before the Botanical Club, A. A. A. S., Brooklyn meeting, 1894.

C. E. BESSEY: *The germination of the macrospores of Marsilia vestita.*

E. F. SMITH: *Tannin as a mordant for staining cell-membranes.*

F. C. NEWCOMBE: *Tannin as a mordant for staining protoplasmic structures.*

W. J. BEAL: *The use of measurements in the identification of grasses.*

L. R. JONES: *The decrease of oat-smut in Vermont.*

B. T. GALLOWAY, E. F. SMITH and G. H. HICKS: *Formaline as a preserving fluid.*

N. L. BRITTON: *The check-list of plants of the northeastern states.*

E. F. SMITH: *The bacterial disease of cucumbers with an exhibit of photomicrographs.*

C. E. BESSEY: *Extreme decapitalization.*

L. R. JONES: *A Haematococcus for class-demonstration of motile gametes.*

E. J. DURAND: *Sporangial trichomes on certain ferns.*

ARTHUR HOLLICK: *The significance of stipules from the standpoint of paleobotany.*

C. R. BARNES: *The finding of a considerable quantity of Eustichia Norvegica in Wisconsin, in fruiting stages.*

J. J. DAVIS: *Gonidial chains of Entyloma flœrkeæ.*

B. D. HALSTED: *Solandi printing of variegated leaves.*

C. E. BESSEY: *A better pronunciation of botanical terms.*

B. D. HALSTED: *The peach-spotting fungus as a leaf parasite.*

E. J. DURAND: *Development of Olpidium sp., one of the Chytridiaceæ.*

B. D. HALSTED: *A peculiar discoloration of the Paeonia leaf.*

E. F. SMITH: *A simple method of making pure cultures of fungi.*

C. E. BESSEY and ROSCOE POUND: *The work of the Botanical Seminar of Nebraska.*

M. B. WAITE: *The killing of young shoots of the pear by excessive transpiration.*

M. B. WAITE: *Staining the flagella of bacteria.*

BRIEFER ARTICLES.

Pleodorina in Indiana.—On the eleventh of last May the writer collected specimens of *Callitriche heterophylla* Pursh, and *Nitella* sp.? from a shallow, stagnant pond near Bloomington, Ind. A small quantity of this material was kept fresh in a bell-jar in a north window of the laboratory. On June 29th, while searching for unicellular algæ for the use of my class, I noticed numbers of little, pale green specks along the wall of the glass vessel below the surface of the water. They were at once taken to be Volvox. A microscopic examination convinced me, however, that these plants differed from any Volvox that I had ever seen.

Having no special literature on the Volvocineæ, I did not feel certain as to the precise limits of the genus Volvox.

However, a study of the life history was begun immediately as, in the specimens in question, the asexual development from the gonidia could be very readily followed.

While in the midst of my investigations, the BOTANICAL GAZETTE for July, to my agreeable surprise, brought me the paper of Mr. W. R. Shaw of Stanford University on "Pleodorina, a new genus of the Volvocineæ."

A glance at this paper convinced me that the organism at hand was *Pleodorina Californica* Shaw, and a closer comparison confirmed the opinion. Almost every detail in the study made by me agreed with those presented in Mr. Shaw's paper.

Together with few minor details which may be of little importance, some of the specimens examined by me, however, were a little larger than the measurements given in the paper. The plant body of the largest individuals observed, measured 352μ in diameter, the gonidia just previous to the first division, 24–32μ; vegetative cells, just one-half of the gonidia in the same colony, 12–16μ.

Up to July 27th the plants, then numbering thousands in the same bell-jar, were in good condition, multiplying rapidly.

It is to be hoped that the sexual reproduction, if possessed by this plant, may occur and be observed this fall.—DAVID M. MOTTIER, *Indiana University, Bloomington*.

Pleodorina in Illinois.—The new alga *Pleodorina Californica* described in the July GAZETTE was found during the month of June in abundance at Havana, Ill., by Prof. T. J. Burrill and myself. This is where the University of Illinois has its new Experiment Station for the study of aquatic life, and is a rich collecting ground for algæ.—G. P. CLINTON, *Champaign, Ill.*

Fruiting Eustichia Norvegica Brid. — This rare moss has been known in the vegetative condition for many years. It occurs in different parts of the world, and has been found in half a dozen or more localities in this country. In the fruiting condition, however, it is little known. Mrs. E. G. Britton discovered it in fruit at the dells of the Wisconsin river, near Kilbourn City, Wisconsin, in July, 1883, and described the fruit in the *Bulletin* of the Torrey Botanical Club 10: 99. 1883. Seventeen fruiting specimens were found. These, up to the present summer, were all that were known to exist. The herbarium of the University of Wisconsin is now, however, in possession of a sufficient quantity in fruiting condition to distribute to all bryologists desiring it.[1]

While working on a botanical survey of the Wisconsin river valley, Mr. F. D. Heald and I collected between eight and nine hundred fruiting specimens in "Witches' Gulch," near Kilbourn City, Wisconsin, in the latter part of July of the present year.

Among the capsules are many one year old at least, while it is quite possible that some of them are older. This would indicate that the difficulty experienced in finding fruiting material is due chiefly to rarity of fructification and not to the disappearance of fruiting parts soon after maturity. The capsules probably matured in July. Part of the material collected by Mrs. Britton in the early part of July is immature. The capsules collected this summer are, with scarcely an exception, mature, many of them having already dehisced. An examination of the capsules shows the entire absence of peristome and annulus.—L. S. CHENEY, *University of Wisconsin.*

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[1] Applications for specimens must be accompanied by postage (unless from foreign countries) and should be addressed to the Department of Botany, University of Wisconsin, Madison, Wis., U. S. A.

CURRENT LITERATURE.

The flora of Mt. Desert.

THE FLORA of Mount Desert has for some years been the object of careful study, and the result has now appeared in a very handsome volume.[2] An outline of the geology of the island is furnished by Professor W. M. Davis of Harvard The summary shows 751 phanerogams, 47 pteridophytes, 271 bryophytes, and 421 thallophytes excluding funi and myxomycetes, which have not been collected. A carefully prepared introduction gives a general description of Mt. Desert and its flora. Some of the noteworthy features are the arctic character of the flora, the very small representation of introduced foreign plants, the scanty showing of Leguminosæ, the entire absence of Asclepias, Gentiana, and other well known genera, and the remarkable beauty and deepness of coloration.

The introduction also contains a somewhat extended discussion of nomenclature, brought on by the recent attempts of American botanists towards stability. In the list the nomenclature of the last edition of Gray's Manual is followed, a principle which the GAZETTE has always strongly advocated for local lists. In the discussion of what is known as the "Rochester Code," however, the argument is weakened by the frequent imputation of unscientific motives to those concerned in framing the code. We believe in difference of opinion and a strong expression of it, in fact there was an abundance of this among those who by mutual concession framed the code, but we do not see that any position is strengthened by calling those who oppose it names. We could wish that the strictures, which are good enough in their way, had been pruned of the gratuitous assumption of motives which we know do not exist. When the botanists who were at Rochester learn that "less than one day was sufficient for this committee" (on nomenclature) they will be somewhat surprised, for they were not aware that any point was considered that had not been under discussion for years. The mistakes made were certainly only those of judgment and not of intention. Of course there was no thought that the code would be binding except upon those who chose to follow it, but it was believed that the best interests of American botany would be subserved by coming to some agreement concerning nomenclature.

[2] RAND, EDWARD L. and REDFIELD, JOHN H.—A preliminary catalogue of the plants growing on Mt. Desert and the adjacent islands. With a map. 8vo. pp. 286. Cambridge: University Press. 1894.

Minor Notices.

ANOTHER practical botany[1] has been added to the list of laboratory guides, this time for beginners. Professor Bower has really given us an abridgement of his "Course of Practical Instruction in Botany," so that its spirit and method is familiar. The book can be of excellent service in our secondary schools, and even in the elementary courses of most colleges, provided, always, that it is in the hands of a competent teacher, and this any book demands. The information as to methods of preparation, and the introductory exercises on the structure of the vegetable cell, and the common micro-chemical reactions, are very helpful to the inexperienced teacher. As is known, the author begins with the highest types, an order of treatment which we do not consider scientific or necessary. There is no reason why the mucor of the last study should be any more difficult for a beginner to see and to understand than the tissues and ovule structures of the first types. The excellence of the work demanded, however, and the scientific spirit of it all, needs no comment.

THE PROCEEDINGS of the Madison Botanical Congress have recently been published by Secretary J. C. Arthur. The issue was much delayed by the dilatoriness of speakers and committeemen in revising manuscript and proof sheets. The report makes a handsomely printed pamphlet of sixty pages with an index by which all references to the matters discussed can easily be found. Copies may be obtained by application to Dr. J. C. Arthur, Lafayette, Indiana.

IN CONNECTION with the study of some recent collections, Mr. F. H. Knowlton[2] has given a review of the fossil flora of Alaska. An historical review, list of species, and discussion of beds are given. Of the 115 forms enumerated forty-six are peculiar to Alaska. The same author has published in *The Journal of Geology* (May–June, 1894) an instructive paper on "Fossil plants as an aid to geology."

A RECENT contribution[3] from the Gray Herbarium contains descriptions of some twenty-five new Mexican plants, among them the beautiful new pine (P. Lumholtzii) with dense pendulous foliage recently figured in *Scribner's Magazine.*

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[1] BOWER, F. O.—Practical botany for beginners. pp. xi. 275. Macmillan & Co., London and New York, 1894. 90 cents.

[2] KNOWLTON, F. H.—A review of the fossil flora of Alaska, with descriptions of new species. Proc. U. S. Nat. Mus. **17:** 207–240. *pl. 1.* 1894.

[3] ROBINSON, B. L. and FERNALD, M. L.—New plants collected by Messrs. C. V. Hartman and C. E. Lloyd upon an archæological expedition to northwestern Mexico under the direction of Dr. Carl Lumholtz. Proc. Am. Acad. **30:** 114–123. Aug. 27. 1894.

OPEN LETTERS.

Added synonymy.

In noticing the revision of the N. Am. Alsineæ by Dr. B. L. Robinson, in the August number of the GAZETTE, was it *fair* to say that in using the name Spergularia, he has "added to the synonymy of this much vexed group"? Certainly *he* did not add that name to the synonymy, for it is the one which has been in most general use since the time of Presl, and until botanists can settle the relative precedence of the resurrected names Tissa and Buda, those who follow the general usage of half a century can hardly be the ones who "disturb our peace"!—JOHN H. REDFIELD, *Philadelphia, Pa.*

[Naturally no reference was made to the addition of Spergularia to synonymy, but to the consequent addition of new binomial combinations.—EDS.]

Marchantia as a type.

Dr. Underwood's objection to the use of Marchantia as a type in morphological courses of study expressed in several places recently and reiterated in his vice-presidential address at Brooklyn last month seems to me based upon a misunderstanding. I use this plant constantly in my classes, but not, as Dr. Underwood seems to imply it must be used, as a type of the heterogeneous Hepaticæ. Certainly no teacher at all familiar with morphology could make so evident a mistake as to do that. I use it, and I think others also use it, as a type of the very development which Professor Underwood in his admirable address used it to illustrate, viz., the greatest possible complexity of the *thallus*. For neither of the other two lines of development, of a leafy axis or of the sporogone, do I take types from the Hepaticæ. The possibilities in both these directions I find far better illustrated in one of the true mosses, such as a Bryum or a Brachythecium. Were I writing a laboratory handbook for a course in morphology, such as Arthur, Barnes, and Coulter's *Plant Dissection*, or Bower's *Practical Botany*, I am inclined to think I should include the time-honored Marchantia as one of the bryophyte types, in spite of the fact that it is a representative of only a small group of hepatics and that the lowest.—R.

NOTES AND NEWS.

A FINE illustration of Cereus Pecten-aboriginum appears in *Garden and Forest* of August 22d.

THE "Systematic Botany of North America" is rapidly assuming definite shape. Sample pages have been distributed, subscriptions are being received, and certain parts are announced for 1895. Additional work has been begun by numerous botanists, and there is every prospect that this great undertaking will advance steadily to its completion.

IN *Le Botaniste* for July the six papers are all by the editor, M. P.-A. Dangeard, the subjects being: Observations on the green bacteria, Researches in the structure and sexual reproduction of Mucorini, Sexual reproduction of Entyloma Glaucii, Researches in the structure of lichens, Sexual reproduction of Ascomycetes, and Note on an anomalous flower of Tulipa sylvestris.

BY THE BURNING of the Knox Warehouse, in Washington, last month, Prof. F. Lamson-Scribner lost his entire herbarium with the exception of the genus Panicum which he was studying. This was one of the best studied and arranged collections of North American grasses in existence, including many types as well as a number of California species of Dr. Kellogg's collecting, which were in Professor Scribner's hands for study. The loss is quite irreparable, and the GAZETTE begs to extend its sympathy.

THE ORGANIZATION of the Botanical Society of America was completed at Brooklyn, where the charter members were called to meet on August 15th. The report of the committee upon constitution was presented, and after full discussion and amendment was unanimously adopted. This constitution provides that only American botanists engaged in research, who have published work of recognized merit shall be eligible to active membership. Candidates for active membership must be recommended by three active members of the Society, but any nominee may be objected to by any member and if ten members object the name will not be considered by the Council. Nominees may be rejected by two negative votes in the Council, a body of seven, or by one-fifth the votes cast even after submission by Council.

Officers were elected as follows: president, William Trelease; vice-president, Nathaniel Lord Britton; secretary, Charles Reid Barnes; treasurer, John Donnell Smith; additional members of council, Charles Sprague Sargent, Edward Lee Greene.

No new members were elected, as it was considered best to elect the first members in accordance with the rigid provisions of the constitution.

The first annual meeting will be held in Chicago (if the A. A. A. S. meets in San Francisco) shortly before the meeting of the A. A. A. S.

Subscribers are requested to forward no subscriptions for the Botanical Gazette through the READERS UNION PUBLISHING CO., of Lansing, Michigan. We shall have no further dealings with this concern.

PUBLISHERS.

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Missing Numbers.—Will be replaced *free* only when claim is made within 30 days after receipt of the number following.

[Entered at the Post-office at Madison, Wis., as second-class postal matter.]

In the November number will appear:

Nature and distribution of attraction-spheres and centrosomes in vegetable cells, by JOHN H. SCHAFFNER, *Ann Arbor, Mich.*

Notes on dedoublement, by AUG. F. FOERSTE, *Dayton, Ohio.*

Popular American plant names. III, by FANNY D. BERGEN, *Cambridge, Mass.*

A new genus of Umbelliferæ, by JOHN M. COULTER and J. N. ROSE, *Lake Forest, Ills.*, and *Washington, D. C.*

BOTANICAL GAZETTE

OCTOBER, 1894.

Filices Mexicanæ. V.[1]

An enumeration of the ferns collected in Mexico by C. G. Pringle of Charlotte, Vermont, during the seasons 1891–1892 and 1893.

GEORGE E. DAVENPORT.

ACROSTICHUM.[2]

A. conforme Swz. 5,195.
On cliffs, Sierra de las Cruces, Oct. 2, 1892.

A. latifolium Swz. 5,530.
Wet cañons, Colima Mts., 7,000ft alt., March 23, 1893.
Specimens agree very well with Chas. Wright's 996, 969, and 3,958 from Cuba in 1859–1865.

A. recognitum Kze.
Sierra de las Cruces, Aug. 25, 1892.

A. venustum Fée, Mem. 8: 68. 5,196.
Moist banks, Sierra de las Cruces, July 10, 1892.

ADIANTUM.

A. trapæsiforme L. 3,960.
Coffee plantation, hacienda of Tamasopo, Dec. 1, 1891.
A grand species with magnificent decompound fronds, the segments from one to one and a half or more inches long, and, in Mr. Pringle's specimens, "decurved obliquely" as in Hooker and Baker's var. *β*. (*A. pentadactylon* L. & F.).

ANEIMIA.

A. hirsuta Swz. 3,850, including var. *tenella* H. & B. (*A. tenella* Swz.) A more delicately cut form, the pinnæ deeply pinnatifid.

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[1]For numbers I to IV see *Garden and Forest* 4: 448, 483, 519, 555.
[2]The alphabetical order has been adopted for these notes merely for the convenience of an ultimate re-arrangement.

Cool grassy bluffs of barranca near Guadalajara, Sept. 15, 1891.

ASPIDIUM.

A. aculeatum Swz. 5,532.

A slender nearly smooth form from the cañons of the Colima Mts. May 20, 1893.

A. (Polystichum) *melanostictum* Kze. 3,825.

Shaded slopes of barranca of Las Canoas, Aug. 22, 1891. The large cinnamon colored involucres with black centers and ciliated margins appear to fix Mr. Pringle's plant here with reasonable certainty.

A. (Nephrodium) *setosum* Kl. (*N. tetragonum* Hook.) 3,957, *α* and *β*, the two forms so different as to appear like entirely different species, yet not clearly separable by any good characters.

Form *α*, which is simply pinnate with deeply pinnatifid pinnæ six or more inches long and one inch broad, almost exactly matches Fendler's 194 from Venezuela, 1854–55; form *β* is nearly tripinnate in the lower half of the frond and broadly deltoid with unequal-sided pinnæ like *A. spinulosum*, var. *dilatatum*, but the upper part gradually and exactly reproduces form *α*, all other characters being the same in both forms. I am not sure of this determination, but I have found it impossible to place it elsewhere, although I have had it under frequent examination during the past three years.

Banks of a cascade, hacienda of Tamasopo, Dec. 2, 1891.

ASPLENIUM.

A. cicutarium Swz., var. **paleaceum,** n. var. 5,531.

Rachises chaffy, otherwise as in type.

Moist banks, cañons of Colima Mts., May 23, 1893.

A. hastatum Klt. 3,920.

In rich forests, Las Canoas, Oct. 17, 1891.

A. pumilum Swz., var. **laciniatum,** n. var. 5,534.

The divisions deeply cut into linear strap-shaped lobes.

Mossy ledges, barranca of Tepii, Oct. 11, 1893. There is a similar form in the Cambridge Herbarium from Kew (566 from Jamaica) with which this agrees perfectly.

A. rhizophyllum Kze., var. **proliferum,** n. var. 5,533.

Moist banks, cañons of Colima Mts., May 23, 1893.

The exceedingly narrow divisions, and the dareoid appearance of the sori on the upper part of Mr. Pringle's plant led me to look for it in the Darea section of this genus, but Prof. Eaton considers it a mere form of *A. rhizophyllum*, and a more careful examination convinces me that he is right. There are specimens of this species and 5,531 in the Cambridge Herbarium with proliferous fronds, a seemingly not uncommon character in this genus.

A. rubinum, n. sp. 5,191.

Rootstocks tufted, clothed at the crown, and the young croziers covered with blackish-brown fibrillose scales and chaff; fronds clustered, 6 to 15 inches tall, $\frac{3}{8}$ to $\frac{3}{4}$ of an inch broad, pinnate; stipites 2 to 6 inches long, moderately stout, and, as well as the rachises bright ruby colored, smooth and glossy; pinnæ 20 to 30 or more pairs, sessile, or in the larger specimens sub-sessile, variously shaped, mostly unequal-sided, wedge-shaped at base, or sub-dimidiate, the lower side cut away one-half to two-thirds in a curved line with the upper base line parallel with the rachis, lowermost pairs distant, rhomboidal or sub-reniform, margins entire or slightly crenate; surfaces bright green, texture coriaceous, veins obscure, sori large, 1 to 5 pair to a pinna, brown when mature.

Cold cliffs, Sierra de las Cruces, Sept. 11, 1892.

No description can make the distinctive character of this fine ruby-stalked Asplenium perfectly clear, but once seen it is not likely to be mistaken for any other known species. In general appearance and habit it resembles a robust form of *A. Trichomanes*, but the stout red stalks, which extend nearly to the apex of the frond before greening, and the enormous sori render its identification comparatively easy. The back of a mature pinna is a solid mass of brown sporangia, nearly obscuring the persistent indusia and presenting the appearance of an Acrostichum.

A. Shepherdii Spreng. 3,958, *α* and *β*.

Tamasopo cañon, June, 1891.

BOTRYCHIUM.

B. matricariæfolium R. Br. 5,193.

Wet cañons, volcano of Toluca, Sept., 1892.

B. ternatum Swz. 5,192.

Alpine meadows, Sierra de las Cruces, 10,000ft alt., Sept., 1892.

CHEILANTHES.

C. speciosissima A. Br. 4,202 *α* and *β*. (*Plecosorus Mexicana* Fée.)

α, with somewhat rigid fronds densely clothed with rich brown scales; *β* with fronds lax and only sparingly scaly from growing in shady grottos.

Cliffs, Sierra de las Cruces, 11,000^{ft} alt., Sept. 11, 1892.

DICKSONIA.

D. rubiginosa Klf. 3,824.

Rich moist slopes in shade, barranca of Las Canoas, Aug. 18, 1891.

Five to 8^{ft} high, fronds deltoid, 3 to 5^{ft}, stipes 2 to 3^{ft}.

GYMNOGRAMME.

G. Calomelanos Klf., var. *Peruviana* Baker. 4,377. (*G. Peruviana* Desv.)

Calcareous banks and cliffs, barranca near Colima, state of Jalisco, June 4, 1893.

G. Ehrenbergiana Klt., var. **muralis** Pringle (*in litt.*). 4,420.

A cliff-growing dwarf form with chaffy rachises, but without scales. On faces of cliffs near Tequila, July 6, 1893.

G. trifoliata Desv. 4,000.

Barranca of Las Canoas, state of San Luis Potosi, Aug. 15, 1891, growing among willow and cypress bushes.

Specimens bifoliate, and without powder. Judging from the series of specimens at Cambridge, the species is oftener bifoliate than otherwise, and the powder is not always present.

NOTHOLÆNA. This is Robert Brown's original orthography as used by him when he established the genus in 1814, and I do not wish to be quoted as favoring any other. The later orthography of Kaulfuss (1824) in my notes in Garden and Forest, *l. c.*, was not used with my approval, and I do not concede the right of an editor to interfere with an author's manuscript unless it be to correct errors of spelling or grammar. It is not a question of scholarship that we have to consider here, but one of priority and right, and no advocate of the "revised nomenclature" can consistently set aside Brown's original orthography for that of Kaulfuss without doing violence to the very code which he professes to serve.

N. Grayi Davenport. 5,373.

Ledges, barranca of Tequila, Oct. 4, 1893.

Mr. Pringle wrote that "if, as I think, I send you *Noth. Grayi*, it must be from an extreme southerly station, much farther south than before recorded. It was 50 miles west from Guadalajara, where *N. Schaffneri* rather than this species is common."

OPHIOGLOSSUM.

O. crotalophoroides Walt. 4,244.

Moist meadows, Nevado of Toluca, 11,000[ft] alt., Sept. 6, 1892.

O. reticulatum L. 3,816 and 3,995.

3,816 in moist, grassy places under shrubs, Las Canoas, state of San Luis Potosi, Aug. 15, 1891. 3,995 in wet soil near Guadalajara, state of Jalisco, Oct. 5, 1891. Some of the latter specimens seem doubtfully distinct from *O. vulgatum*; but the two species appear to run very closely together, if not into one another, and I doubt very much if they are specifically distinct.

OSMUNDA.

O. regalis L. No number, and should have been in my previous notes.

By streams near Guadalajara, Dec. 13, 1888.

POLYPODIUM.

P. angustifolium Swz., var. *ensifolium* Baker. (*P. ensifolium* Willd.) Specimen numbered 3,803, ticket 3,821.

On trees, barranca of Las Canoas, Aug. 1891.

P. heteromorphum H. & Gr. (*P. variabile* Mett.) 4,145.

A slender and remarkably beautiful Polypodium, with long narrow perennial fronds that increase in length annually, each season's growth being distinctly seen, so that a single frond may have upon it passé, matured and maturing lengths with the apex preparing for the next season's extension. Found "hanging from fissures in sheltered niches and grottos of cold cliffs," summit of Sierra de Las Cruces, 11,000[ft] altitude, Sept. 11, 1892.

P. lepidopteris Kze. 5,359.

On trees, hills of Patzcuaro, July 16, 1891.

P. Martensii Mett. 5,360.
With 5,359. Aug. 3, 1892.

P. pectinatum L. 3,974. A form apparently identical with *P. Paradisæ* L. & F.
Rich woods, hacienda de Tamasopo, Dec. 11, 1891.

P. petiolatum, n. sp. 4,001.
Rootstock stout, half an inch or more in diameter, wide-creeping, and thickly clothed wlth large fulvous (brown) scales: fronds scattered, 2ft or more tall, 15 to 18in broad, pinnate; stipites stout, 6 to 8in long, and (as well as the long stipiform rachises) straw colored, smooth and glossy; lamina divided into from sixteen to twenty pair of long acuminated inear-lanceolate pinnæ 6 to 9in long, three-eighths to one-half lan inch broad, stalked nearly to the top, uppermost sub-sessile, the long terminal one with a pair of small sessile pinnæ below; texture sub-coriaceous, smooth; venation that of Goniophlebium, areolæ uniserial, veins conspicuous, sori prominent, thirty to forty each side of the prominent costa.
On mossy oak, Las Canoas, Aug. 19, 1891.
Mr. Pringle wrote me that this fern "was found on the branches of oaks on the mountain sides about the station of Las Canoas in the eastern part of the state of San Luis Potosi. This must have been near the limit of its distribution —certainly on the western limit and near the dry region where ferns cannot grow on trees—for I searched somewhat widely and found only the two specimens." A very distinct and fine Polypodium.

P. Phyllitidis L. 5,187.
On trees, Tamasopo, Dec. 1, 1891.

P. pilosissimum Mart. & Gal. 4,288.
Mossy rocks, Sierra de las Cruces, 11,000ft, Sept. 11, 1892.

P. Plumula. 3,999.
On ledges, Tamasopo, Dec. 1, 1891.

P. vulgare L. 5,190.
Sierra de las Cruces, 11,000ft, Sept. 11, 1892.

TRICHOMANES.

T. pyxidiferum L. 3,800.
Mossy rocks, Tamasopo Mts., July, 1891.

I have referred Mr. Pringle's specimens to this species merely because I do not find any authentic record of *T. filicula* from this continent.

In the note under *T. filicula* in Synopsis Filicum, Dr. Hooker stated that "he could not distinguish from that species a Mexican plant from Liebmann though labelled *pyxidiferum* on high authority," and I am myself unable to discover any important difference between Mr. Pringle's specimens and some specimens of *T. filicula* which I have from Leprieur's Herbarium (Paris Museum) given to me by Dr. Gray. It is doubtful if the two species are in reality distinct.

T. radicans Swz. 5,535.

Wet cliffs, cañons of Colima Mts., May 23, 1893.

Specimens somewhat larger and coarser than our southern form, but otherwise characteristic.

WOODSIA.

W. mollis J. Smith. 1,865.

Moist banks and ledges near Guadalajara, Nov. 1888.

Should have been included in my previous notes, as should also my acknowledgments to Prof. L. M. Underwood for valuable assistance in verifying some determinations at a time when I was greatly troubled with my eyes, and it would seem to me that I was taking to myself credit for what was not justly my due if I continued my notes without putting myself on record in this manner.

In addition to the foregoing ferns several other species previously recorded were again collected, mostly in, or near the same localities as before, so that it does not appear necessary to record them again here.

ERRATA.

Prof. Underwood has called my attention to Mr. Pringle's 1,441 sent out with the collection of 1887 as *Notholæna candida* (see Fern Notes in *Bulletin* Torrey Bot. Club), which he finds to be *Cheilanthes farinosa* Klf. I fully agree with him and thank him for the correction.

He also writes that his specimens of 449 and 1,959 (see also *Bull.* Torr. Bot. Club) are *Cheilanthes Alabamensis* rather than *C. microphylla*, the species to which I had referred those numbers. My own specimens were somewhat intermediate in character, but with, as I still think, a stronger leaning toward *microphylla* than *Alabamensis.* They are as good *microphylla* as many specimens so named by good authority. It does not, however, matter very much from my point of view, as I consider the two so-called species mere forms of one. That they do run into each other through almost inseparable gradations there can be little question, and Prof. Underwood himself appears to doubt their being distinct.

It is certainly impossible at times to separate specimens satisfactorily, and their variations have not only been made the basis for several untenable species but the two extreme forms have even been put into separate genera.

Dr. Hooker, however, in Species Filicum expressed the opinion that we might "conceive of *C. microphylla* having reached its extreme northern limits in the *C. Alabamensis* of the southern states." I coincide with this view and believe that we should write:

Cheilanthes microphylla Swz.

β. var. *Alabamensis* (Buckley). (*C. Alabamensis* Kze.)

Medford, Mass.

Notes on Cribraria minutissima and Licea minima.

GEORGE A. REX.

Cribraria minutissima Schwz.

There is a marked discrepancy between the original description of this species by Schweinitz[1] drawn from the type specimens now in the Schweinitzian herbarium in the Academy of Natural Sciences of Philadelphia, and the later descriptions of Rostafinski and Massee which were drawn from the Schweinitzian specimens in the Berkeleyan herbarium.

The two specimens apparently differ in important points. The diagnostic description of Schweinitz, however, accurately describes the curiously shaped elongated sporangia of the type, which appear as if ellipsoidal when first developed, becoming finally constricted in the middle when mature. The sporangia have the appearance of being girt by a thread, expanding above and below into two nearly equal globose portions, the diameter at the central constriction being from one-half to three-fourths the diameter of the upper and lower portions. A longitudinal section through the center of a typical sporangium suggests the outline of the figure 8, as was aptly stated by Schweinitz in his description.

Below the constriction, the sporangial wall forms a permanent calyculus, but above, it expands into a globose network of band-like threads only occasionally wider at the intersections, and forming irregular meshes.

The Berkeleyan specimen, on the contrary, is described as having no permanent wall or calyculus, but simply a permanent globose network of the same character as that of the typical specimen.

The marked central constriction found in the type specimens is not, however, a fixed character, according to the observations of the writer, who has seen associated both constricted and unconstricted ellipsoidal sporangia, the latter approaching very closely the obovate sporangia of *Cribraria microscopica* B. & C.

An important point necessary to be considered in this con-

[1] De Schweinitz, L. D., Synopsis Fungorum in America Boreali media degentium. Proc. Am. Philos. Soc. 1831. [Philadelphia.]

nection is the relation of *C. microscopica* B. & C. to the two foregoing Schweinitzian forms. In their spores and network these three forms essentially agree. They vary only in the shape of the sporangium, which is a diagnostic character of no specific value, and in the size or degree of development of the calyculus which must be conceded to be variable and therefore a specific character of doubtful value.

The only species of Cribraria created solely upon the absence of a calyculus as a determining specific factor is *C. dictydioides* Balf.; but the great variability in the size of the calyculus in different gatherings and even in the same gathering of the allied and overlapping species *C. tenella* and *C. intricata* makes the validity of *C. dictydioides* more than doubtful.

Sporangia without calyculi associated with others having minute disciform calyculi are constantly found with the typical net characters of both the above species. The same variability of the calyculus is also found, though to a much less extent, in sporangia of the type of *C. vulgaris* Schrad.

As *C. microscopica* B. & C. differs from typical *C. minutissima* Swz. only in having globose or slightly obovate instead of ellipsoidal sporangia, the writer concludes that it is not specifically distinct, but should be merged in *C. minutissima* Swz. which is the older species.

The Berkeleyan form of *C. minutissima* Swz. holds the same relative position to the type as *C. dictydioides* to *C. intricata* and *C. tenella.* It is a constant variety of *C. minutissima* and could only doubtfully be assigned a separate and valid specific place.

The localities for this species known to the writer are Fairmount Park, Phila.; Shawangunk Mts., N. Y.; Newfield, N. J. (J. B. Ellis); and the original station at Bethlehem, Penn. (Schweinitz). The Berkeleyan variety is probably more frequently found than the typical form.

In the preparation of the preceding notes the writer examined and compared the type of *C. minutissima* Swz. in the Schweinitzian herbarium, with an authentic specimen of *C. microscopica* B. & C. communicated by Dr. Curtis, the collector and one of the authors of the type, to the herbarium of the Academy of Natural Sciences, Philadelphia, which corresponds absolutely to the descriptions of the type by Rostafinski and Massee and is probably a part of the same gathering. Specimens from several private collections, illustrating the Berkeleyan variety, were also examined.

Licea minima Fr.

This obscure and little known species has an interesting developmental history.

The sporangia of the American, like those of the European specimens, vary in color greatly. All, except one, of several gatherings from various American localities examined by the writer were of various shades of chestnut or umber brown. In the exception, the color of the sporangial wall was dull black by reflected light, but dark reddish brown or black by transmitted light.

The upper surface of the sporangia in all of the gatherings, was divided by seams or ridges into from four to six parts. In the brown specimens these seams were of a darker brown than the adjacent parts, but in the black specimens they were jet black, smooth and shining. They extend from the base to the center of the surface of the sporangia when of the usual depressed hemispherical form, but to a short central or apical ridge when the sporangia are elongated. These ridges are sutural in character and mark the lines of the rupture of the sporangia upon the dispersion of the spores. The rupture takes place through the middle of the sutures and the resulting segments of the sporangial wall become partly reflexed, thus giving a serrated margin to the cup-like sporangial cavity left by the scattered spores.

The location of these sutures is indicated early in the development and differentiation of the sporangia from the plasmodium.

This fact the writer was able to verify while observing the very interesting development of the sporangia of the black form.

When found, the plasmodium had just entered the first stage of differentiation and had formed cushion-shaped masses of a uniform dull yellow color, probably two and three times the diameter of the mature sporangia. As the development and maturation advanced, the plasmodic masses diminished correspondingly in size, and in the smooth yellow plasmodium the sutures characterizing the mature sporangia began to differentiate, first as double rows of minute dark garnet colored pigment points which gradually grew larger and darker and finally blended, forming black shiny sutures at maturity. While the sutures were developing, the whole sporangial surface also changed from yellow to dark garnet, and finally black, the pigmentation commencing at the sutural and basal lines and spreading thence toward the centers of the segments of the sporangial wall. The lines of rupture occurred between the rows of pigment points which first outlined the sutures. On examination of the matured sporangial wall under proper microscopical conditions of light and high amplification, a marginal line of rounded cells, varying in degree in different specimens, may usually be seen following the outline of the segments and marking the position of the primary sutural points or foci of pigmentation.

This species will probably be found to be as widely distributed in the northern United States as in northern Europe, where only it has yet been recorded. It was recorded by Schweinitz in his herbarium and in his synopsis of North American fungi under the name of *Licea pusilla* Schrad., with which species it is probably often confounded.

The writer is indebted to the courtesy of Arthur Lister, Esq., of London, for the identification of his specimens with authentic specimens of the species.

The American localities for this species, known to the writer, are Philadelphia, Pa.; Adirondack Mts., N. Y.; and Newfield, N. J. (J. B. Ellis).

Philadelphia, Pa.

Eduard Strasburger.

JAMES ELLIS HUMPHREY.

WITH PORTRAIT—PLATE XXXI.

No name has been more familiar to botanists during the past fifteen years and no work has attracted greater attention or contributed more to the progress of our science than that of Eduard Strasburger. Therefore it has been thought that American botanists may be interested in a brief sketch of the man by way of supplement to what they already know of his work. The time is yet, we trust, far distant when any complete account of his life and work will be possible. But it seems legitimate to recognize the interest which naturally attaches to the personality and surroundings of every leader of thought. The following pages are simply the record of the permanent impressions remaining to a student after several months of daily intercourse, begun with no knowledge of the man but such as may be gained from his published work.

Eduard Strasburger is a native of Russian Poland, and has just completed his fiftieth year. He is, therefore, in the prime of his powers. He was educated at Warsaw and in Germany, and showed such promise as a young man that he was called at the age of twenty-five to the university at Jena. There he remained until 1881, when he accepted a call to Bonn as the successor of Hanstein; and none of the calls since received has tempted him from this congenial post. Later he was given the title "Geheimer Regierungsrath," the official distinction which the Prussian government confers upon its citizens of profound scholarship or other great attainments.

The results of his researches during the past twenty-five years are recorded in about as many published papers and volumes, familiar to botanists everywhere. In looking over the chronological list one is struck by the homogeneity of the work, and a little examination affords striking proof of that development of one research from a previous one, so characteristic of the greatest investigators. Entering upon a field which had shortly before been shown by the path-breaking work of Hofmeister to be so full of interest and far-reaching significance, the reproduction of the gymnosperms, he was naturally led to the comparative study of the angiosperms also, and, one question leading to another, deeper and deeper into the investigation of the processes involved in the reproduction of the flowering plants, and of their significance. These studies naturally and early led to the investigation of the cell-contents, and especially of the nucleus, whose fundamental importance in the activity of the cell becomes so quickly apparent to the student. And it is perhaps through his work upon the indirect division of the nucleus that his name is most widely known. Prof. Strasburger himself states that his attention was first attracted to the karyokinetic figures by their conspicuousness in the endosperm of certain Coniferæ, and their superficial resemblance to the figures formed about the poles of a magnet. Studies of the cell contents inevitably brought up also questions as to the structure and growth of its wall. Apart from the two related lines of research just indicated, his chief work has been that which has resulted in his classic volume on the structure and functions of the vascular bundles in plants, which is also the bulkiest of his publications; so that he always refers to it in conversation as "Mein grosses Buch."

Just outside the corporate limits of Bonn, in the suburb of Poppelsdorf, stands the "Poppelsdorfer Schloss," up to the beginning of the present century a summer palace of the Archbishop-Electors of Cologne. It is a huge square building of two stories, about a central circular court, and is occupied by the Natural History department of the university, containing also the residence of the professor of botany. The botanical establishment occupies the entire upper floor of the southeasterly side of the square, and more than half of that of the northeasterly or front side. The fact that the building was erected in the first half of the last century, and for quite another use, will explain why it is poorly adapted for laboratory purposes. Yet, since the windows are large, and one finds abundant room and all necessary apparatus, he has no reason for complaint. The Botanical Institute includes a lecture room, well supplied with wall charts and diagrams, a laboratory for elementary and one for advanced students, and private rooms for the professor extraordinarius, Prof. Schimper, and for the assistant, besides storage room for apparatus, reagents and alcoholic material.

Prof. Strasburger devotes the two rooms of his residence which adjoin the institute to his own work, one serving as library, the other as laboratory. These rooms are simply furnished, but their contents show that their occupant denies himself nothing that can really aid his work; and their scrupulous neatness and orderliness mark him as a careful and systematic man. Everything has its place and is to be found there when not in use. The library is very complete in modern botanical literature, and the space required for the alphabetical classification of the pamphlets, chiefly authors' reprints, is calculated to impress one with the volume of the literature of botany. Perhaps nothing serves to give a better idea of the rate at which this volume is increasing than a glance through the undistributed accumulation of two or three months on a shelf here.

The principal windows of the professor's residence and of the laboratories overlook the old palace garden, which has been the botanic garden since the foundation of the university in 1818. This is well laid out and well stocked. The out-of-door part has thus far received the chief attention of Prof. Strasburger, who is *ex officio* its director. This consists of an open level plot, laid out in beds for the systematic display of the vascular plants, and bordered at one end by a small pond which is formed by the widening of a part of the old palace moat and gives suitable ground for aquatics and swamp plants. On each side of the "system" lie the two parts of the arboretum, which contains many large and fine trees, including not a few American species. I noted large and flourishing specimens of *Quercus rubra*, *Juglans nigra*, and *Liriodendron tulipifera*, among others; while the blooming of our red maple was almost the first tangible evidence that the dreary drizzle that passes for winter in the Rhine valley was giving place to spring. The garden is rich in conifers, as the inspector, Herr Beissner, is a leading authority on this group. One of the oldest and most striking of them is a beautiful cedar of Lebanon, which is quite hardy there. There are also sections for officinal plants and poisonous plants, and a biological section where one finds grouped together in one bed plants which have solved a given biological problem in a similar way, without regard to natural relationships. This section was laid out under the present director and was one of the first of its kind in Germany. Most gardens now give more or less attention to such an arrangement, whose value is too evident to need emphasis. The greenhouses, though partly old and in poor condition, contain some interesting things. Strikingly good are some large aroids and cycads and two tubs of splendid plants of *Strelitzia Reginæ* that produce every spring thirty or forty flower-stalks, and, after artificial pollination, develop good seeds. The palm-house and *Victoria*-house are new and good, and there is always something interesting to be seen in the propagation houses.

So much for the place where his work is done. Personally Prof. Strasburger is spare in figure and above the medium height, but his devotion to the microscope has given to his shoulders the student's stoop in a marked degree. His serious face and deep-set penetrating eyes can light up most pleasantly, as at the moment when the accompanying excellent likeness was taken.

In the lecture room he speaks very distinctly and earnestly, and presents his subject in clear and attractive fashion. He throws his whole thought and energy into the matter in hand, often showing deep feeling, and impressing the most careless hearer with his own profound belief in the interest and importance of what he presents. A lecture of three quarters of an hour is thus often very exhausting, but it cannot be doubted that its influence on the audience is far more real and lasting than that of a speaker of less enthusiastic temperament. In the laboratory the same qualities are prominent. His real interest in the work of each student, hearty appreciation of good work, and pressing curiosity for new facts stimulate all to their best efforts. The earnest student does not require much time to discover that no books, no piece of apparatus, no plant in the whole establishment, which can facilitate his work will be withheld. Should he feel hesitancy in asking often for apparatus which is private property, or in mutilating a rare plant, he is met by the question: "What is it here for?" This geniality and generosity in the interest of his science is thoroughly characteristic of Prof. Strasburger. Earnestness is the sure passport to his fullest aid and sympathy, and is assumed in every new comer until he has shown the contrary.

In his private work he is eager, persistent, indefatigable. Looking at a subject from every side, following up every clue, welcoming evidence from every source, and with a really extraordinary capacity for accomplishing results, one who knew only the man could prophesy the quality of his work. One recognizes qualities of the ideal investigator in his zeal for the truth, no matter whose theories suffer, his openness to conviction, and his freedom from petty jealousy. He has pronounced views on disputed questions, and decided opinions of the work of others; yet one soon comes to feel that there is none of his views that cannot instantly be given up, and none of his opinions that cannot be modified when the accumulation of evidence shows it to be necessary. If he sifts evidence most critically and demands that it be ample, one feels so much the more confidence in his conclusions.

His quick, nervous manner is in marked contrast to the usual phlegmatic calmness of the native German, and is sometimes brusque to the verge of abruptness. But one quickly learns that this is but the expression of his intense earnestness and concentration upon the subject in mind, to the exclusion of all non-essentials. Finally, one's admiration daily increases as his marvelous grasp of the whole field of morphology and physiology is brought out by the discussion of the problems constantly arising in the laboratory. One recognizes a growing consciousness of the presence of a master mind, and a growing delight in contact with it. It is the possibility of the free development of such minds and of the fruition in them of the true scientific spirit in an atmosphere of complete "Lehrfreiheit und Lernfreiheit" that constitutes the chief glory of the German university.

Weymouth Heights, Mass.

Noteworthy anatomical and physiological researches.

Physiological action at a distance.

Dr. Elfving has published an additional paper[1] concerning the effect of different bodies upon the sporangiophores of *Phycomyces nitens*. Errera (see BOT. GAZ. **18**: 196. 1893) explained the attractive or repulsive effect of different metals, etc., upon the organs named as manifestations of hydrotropism in the latter. Elfving now publishes new experiments. If iron acts as a hygroscopic body upon the negatively hydrotropic sporangiophores, we may expect to see the phenomenon most plainly when the fungus is exposed to the influence of such highly hygroscopic bodies as calcium chloride. The result was, however, negative.

A very hygroscopic plate of gypsum ($80 \times 35 \times 10^{mm}$), dried at 100° C., and placed among the sporangiophores in an atmosphere saturated with water, had no effect whatever upon these. [To those who have done experimental work with hydrotropism, this is no wonder, since there was no hygroscopic variation to act upon the sporangiophores. Errera says, however, that a hydrotropic organ bends towards a place "not where it will find a maximum or minimum of moisture, but where it will, within certain limits, transpire most or least;" on the other hand, he asserts, that the movements or streaming of the molecules in the air is the source of hydrotropic irritability. The first statement is contradicted by the experiments of Du Hamel, Knight, Johnson, Dutrochet, Duchartre, Sachs, Pfeffer, and Molisch.] This gypsum plate condensed 1.665^{gm} of water. An iron plate (surface of $4950^{sq. mm}$) had a well marked attractive effect, and condensed only 3.5^{mgm} of water.

Elfving comes to the conclusion that these phenomena are caused by molecular movements. Highly polished steel and platinum have very little effect upon the sporangiophores, but if these metals are exposed to direct sunlight for a long time they become active, i. e., they are brought into such a condition that they attract said organs. This active condition only lasts for some hours, and then it disappears.

[1] Zur Kenntniss d. pflanzlichen Irritabilität.—Sep. from Oefversigt af Finska Vetensk. Soc. Foerh. Haeft 36. 1893.

We know that a number of non-phosphorescent bodies emit rays of light after having been under the influence of the latter. The duration of this condition is from a few minutes to twenty-four hours. Metals like steel and iron are non-phosphorescent, but we have here a new form of this phenomenon, dark phosphorescence. It is the light, and not the heat which produces the effect named upon the metals; the color of the rays does not seem to have any power to produce in the metals the effect described above. Zinc becomes active by heating alone; when experimenting with this body, Elfving found that it acts as a positive thermotropic agent. On copper, cobalt, nickel, tin, lead, and glass, heating (as above) alone did not produce the activity, although these metals and the glass were heated until they were nearly melting, and then allowed to cool so far that the hand could not feel the heat.

Elfving concludes: "Es scheint mir dann wenig befremdend anzunehmen, dass auch Molekularschwingungen, welche den Körpern selbst innewohnen, oder irgend eine in denselben stattfindende Veränderung begleiten, ähnliche physiologische Wirkungen hervorrufen können. Was speciell die Metalle betrifft, zeigt uns ja auch die Metallotherapie Wirkungen, die entschieden für solche sprechen."—J. CHRISTIAN BAY.

Color bodies in seeds and seedlings.[2]

In this paper Famintzin gives the results of his investigations on the origin of chlorophyll in plants, a subject concerning which there is much uncertainty and difference of opinion, as may be seen in the fact that Bredow and Belzung who studied this question came to diametrically opposite conclusions.

Famintzin's attention was directed principally to the ripe seeds of Helianthus. Microtome sections were placed in Helianthus oil, whereby colorless choromatophores, 1.5–2.5μ in diameter, were distinguished without further treatment, although their presence was more easily discernible when the sections had been slightly moistened with the breath. The chromatophores are situated partly in the spaces between the aleurone grains and partly on the surface of the latter and upon the cell nucleus.

[2] FAMINTZIN, A. Ueber das Schicksal der Chlorophyllkörner in Samen und Keimlingen, 16 pp., 1 plate. Arbeiten des botanischen Laboratoriums der Akadamie, St. Petersburg, 1893. No. 5. Abst. in Botan. Centralbl. 58: 378–9. 1894.

Their presence in all of the embryo cells may be demonstrated by treating the embryo with acid fuchsin, the chromatophores and a thin layer of plasma surrounding the aleurone grains taking the stain. This demonstration is facilitated by previously treating the sections with acetic acid which causes the aleurone grains to swell and finally to dissolve.

The swelling of the aleurone grains take place normally in the early stages of germination, producing a similar effect as when treated with acetic acid.

The chromatophores are frequently found closely pressed together in groups of considerable size which are liable to be mistaken for single bodies.

In germinating seeds the colorless chromatophores may be easily made out by the acid fuchsin stain. The author discovered a further means of distinguishing them in resting as well as germinating seeds by the use of ammonia, an alkali, or alkaline carbonate. The chromatophores were found to contain chromogen which, by means of these reagents, was transformed into a golden-yellow pigment. If thin sections of the Helianthus seeds are placed in a moist chamber with access of air, the chromatophores, owing to the presence of chromogen, become spontaneously colored, taking on at first a bluish-green, and later a yellowish-brown tint.

A comparison of sections of ripe seeds with those of seedlings of different ages, including those containing chlorophyll-green chromatophores, showed all stages of transformation so that it is not to be doubted that the chlorophyll grains of the seedling arise from the colorless chromatophores of the seed. This result was confirmed by a study of the seeds of Lupinus albo-coccineus.

A later and shorter paper by Famintzin discusses the chromogen of Helianthus seeds. At present the author is engaged in a study of the relations of this pigment to xanthophyll and chlorophyll, both of which are probably derived from chromogen in the process of germination. Unfortunately the original papers are in Russian, hence inaccessible to the majority of scientific readers.—G. H. HICKS.

Investigations on pine and oak wood.[3]

This series of investigations by Dr. R. Hartig, begun in 1891 and completed early in the present year are a continuation of investigations begun many years ago; and they are to be followed by others by the same author dealing especially with the influences exerted by the soil in which trees grow, and the results obtained by growing trees in masses and in the open. While the investigations were conducted in accordance with scientific methods nothing that will be of value to the practical forester has been omitted.

PINE.—The trees studied were grouped in five or six classes according to diameter at a given height above the ground. For convenience periods of ten or twenty years are taken as units, each designated as a growth period. Classes one, two, and three attained the maximum annual growth in height in the growth period between thirty and forty years; class four a decade earlier; class five continued its maximum annual growth nearly twenty years, i. e., from twenty to forty. Class six did not reach its greatest growth until the two periods between forty and sixty years. The last tree had early fallen behind the others in growth and was consequently overshadowed by them. By the time the forest was forty years old class six was so completely shaded that a rapid growth in height became necessary in order to obtain sunlight.

In a pine tree one hundred years old five of the annual rings of wood, within the last twenty years of growth, did not extend down to a point 1.3 meters above the ground; four were lacking at a point 3.5 meters above the ground; two at 5.5 meters; and one at 7.7 meters. Two of these short rings were formed more than ten years before the tree died. This indicates an exceedingly interesting physiological fact, namely that the cambium may remain inactive for years without losing its power of cell-division.

As a result of these and some earlier investigations the author derives his theory for the formation of the annual ring. Briefly stated it is as follows: The wood formed in the early part of the season is composed chiefly of large vessels with wide lumina. These are designated as conducting organs. It is along these that the larger portion of the transpiration stream passes. When a sufficient quantity of conducting tis-

[3]ROBERT HARTIG.—Forstlich-naturwissenschaftliche Zeitschrift. **1:** 129, 169, 209. 1892.—**2:** 49, 249, 289. 1893.—**3:** 1, 49, 172, 193. 1894.

sue has been formed wood composed of smaller, much thicker walled cells is produced.

In pine forests of recent growth the maximum thickness of the annual ring is found in the first ten years. In trees grown in the primeval forest, the maximum thickness is not reached until the one hundredth year; sometimes as late as the one hundred fiftieth or sixtieth. The thickness of the annual ring is greater in the upper part of the trunk than in the lower, excepting in trees grown in the open. This is due to two reasons: First, the action of the cambium begins three or four weeks earlier in the tops of closely growing pines than in the lower parts of the trunks, thus producing a greater number of cells above than below in the season; second, as the nourishment of the tree must pass from the top to all lower parts, the upper part is at all times supplied with a greater quantity of material for cell formation than the lower.

The quality of timber is found to differ very greatly, not only in different trees grown under apparently the same external conditions, but also in different parts of the same tree.

Of the timber from recently grown pine forests, the first formed is the poorest, the value increasing with each year's production. Pine trees growing in the shade, having comparatively little transpiration, and with growth beginning late in the season, have valuable wood from the beginning. Trees grown well up the sides of mountains or in wet localities have the best wood formed early.

The amount of water present decreases from the outer part of the tree to the inner, with a sudden falling off, in passing from sap-wood to heart-wood. The relative amount of alburnum to duramen is not always the same on different sides of the same tree. There may be a difference of as much as ten annual rings. The percentage of shrinkage in heart-wood of pine is much less than that of sap-wood. In comparison it is interesting to note that in the beech the percentage of shrinkage is the same for the old and young trees, for sap-wood and heart-wood, while in the oak the shrinkage is much greater in the sap-wood. The smaller amount of shrinkage in the heart-wood of pine and oak is due to the deposition of the material which characterizes heart-wood, in the micellar interstices of its cell walls.

A difference in size of trees of the same age is very closely related to the difference in size of the elements composing them.

OAK.—The trees used in the work upon oak wood were felled at different times during the season, beginning May 2. At this time, though swelling of the buds was not perceptible, the first large vessels were fully formed. The activity of the cambium had doubtless begun in the last week in April. Activity in this tree had begun in all aerial parts at the same time. On the 6th of June the cambium of the roots one-half meter from the stem was still dormant. By the 21st of June the annual growth of stem was half completed. When compared with the preceding annual ring the thickness of the forming ring was found to vary from .45 to .72. On the 19th of August the formation of wood at the base of the trunk had ceased, in the upper part of the trunk the cells were still thinwalled and unlignified, while in the smaller branches cell-formation was still going on. By the 5th of September the formation of wood had ceased in all parts of the tree. The time required for the formation of the annual ring is thus shown to be a little more than four months, extending from last third of April to the last of August. In this connection the author states that in red beech and pine growth does not begin until about four weeks later, being completed in the pine as early as Aug. 10th, and in the beech but little later, making the time required for formation of an annual ring in the beech and pine about two and a half months.

At the time that shoots and leaves are developing, a complete transformation of the starch in the smaller branches takes place. In the older parts of the tree the starch of the bark (phloem and cortex) is first changed for the nourishment of the cambium. At the beginning of June for a short time all starch disappears from the sap-wood. This disappearance has already begun in the upper part of the trunk by the middle of May. The disappearance of starch progresses inward and downward, and is completed by the 6th of June, only the starch of the roots remaining unchanged. By the middle of June the storing of food in the form of starch has begun in the outer sap-wood layers of the trunk and of branches a few years old. The 1–3-year-old twigs are still without starch. The newer sap-wood is still empty. The youngest wood-ring, on the contrary, shows some starch in the vicinity of the large vessels. Traces of it are also found in the phloem. At the beginning of July all parts of the tree are well stocked with reserve starch. Its accumulation in the phloem has been more rapid in the upper part of the tree than in the lower. From the beginning of August to the middle starch is entirely wanting in the phlöem of the branches. In the phloem of the stem only traces of it are found in the outer part. It is assumed that the starch has been withdrawn from the phloem a second time to be used in the growth of the phloem itself. Not until the beginning of September has the accumulation of reserve food begun again in the phloem, and then only in the lower part of the stem. As late as the 30th of September the bark of the 1–2-year-old twigs is still free of starch, although it is abundantly supplied with it by the end of October. In December the starch has been changed into sugar and oil.

The amount of water in oak wood taken from different parts of the same tree varies considerably. It is very abundant, as a rule, in the outer layers of sap-wood; less so in the inner layers; while the outer portion of the heart-wood is comparatively poor in water with a constantly increasing amount as one nears the center of the tree. Taken as a whole the heart-wood usually contains a larger percentage of water than the sap-wood. The wood of the root-shaft contains more water than that of any other part of the tree. The small roots, however, seem to be poor in water. There is a decrease in the amount of water present in passing from the base of the tree toward the crown. This decrease continues in very old trees to the ends of the twigs. In young trees the diminution is continued to the upper end of bole, but from here to the extremities of the twigs, there is a constant increase. In perfectly air-dry oak wood, to every 100 volumes of the wood substance there are 19 to 20 volumes of imbibition water.

In reviewing the results of his investigations, the author calls attention to one fact of especial interest from a physiological standpoint; the adaptation of the anatomical structure of the wood of trees to their needs as produced by external conditions. The smaller roots, which either do not perform any mechanical function for the tree, or if so, only to a limited degree, contain no trace of mechanical tissue. The larger roots and root-shaft, on the contrary, have so much mechanical tissue that they furnish well nigh the strongest wood of the tree. In these places strong wood is necessary for resisting the force of winds. If for any reason the transpiration of a tree is large in proportion to its conducting tissue, the wood of the tree will be composed largely of conducting and storage tissue; on the other hand, if the amount of transpiration is limited to any considerable degree, less conducting tissue will be required and the tree will have at its disposal a larger quantity of plastic material from which to produce mechanical tissue.—L. S. CHENEY.

Adaptation of African plants to climate.[4]

After some introductory remarks upon the highly interesting flora of Cape Colony, the author describes the different ways in which the plants are adapted to the climate. The variety of arrangements for this purpose is very great and may be considered from different points of view. The evaporation is prevented by reduction of the leaves, either by the development of small leaf-blades, or by transferring their function to green stems. Stapelia, Euphorbia and the imported Opuntia illustrate the last case, while small or narrow leaves are very common, for instance in Bruniaceæ, many Compositæ, and others. Some other plants show the surface of the leaves impregnated with substances that are impermeable to water, and this is to be observed in Aloe, Protea, Myrica and several others. The cuticle, or a cover of wax or silica, forms the protective medium in these plants.

A covering of hairs is also very common, by which the communication between the atmosphere and the air within becomes greatly impeded. Leucadendron, Helichrysum, several Leguminosæ, and Proteaceæ are protected in this way.

Secreted mineral substances may also form a protecting layer over the whole leaf as in Tamarix, or only over the depressions in which the stomata are situated, as in Statice, Vogelia, and other Plumbagineæ.

Such arrangements as the placing of the stomata in depressions or in grooves of leaves and stems, or under the reflexed edges of the leaves are also common in this vegetation.

Eucalyptus globulus and Protea grandiflora illustrate the case in which the leaves assume the most favorable position towards the sun.

There are also plants which possess reservoirs in their stems, rhizomes, or leaves. Such plants are the delicate herb, Ele-

[4] MARLOTH, R.—Some adaptations of South African plants to the climate. Trans. South African Phil. Soc. **6**: 31.

phantorhiza Burchellii, which has a huge watery rhizome, sometimes weighing ten pounds. Several Asclepiadeæ of the Kalahari region accumulate so much water in their tubers that the bushmen often depend entirely on it. The Stapelias and Euphorbias store the water in their stems and retain it with great tenacity. The remarkable Cissus Cramerianus of Damaraland has a large fleshy trunk and develops only a few thick branches.

Too rapid evaporation may also be prevented by sap contents of various composition, as for instance slime, gum or salt. The succulents are protected in this way, gum occurring in the Acacias, salt in Augea Capensis and Zygophyllum Marlothii. The salt is often deposited in such quantities that during the drying of the plant it crystallizes and forms a thick crust on it.

Hairs, glands or sheaths are the organs which enable the plant to absorb the dew. This is for instance the case with Salsola Zeyheri from the Kalahari region, where rain is rare. The depressed glands at the base of the leaves of Acacias seem to serve for the same purpose, for drops of dew running down along the rhachis must moisten them. Watsonia Meriana is protected by the large sheaths, which were found to contain water even many weeks after rain has fallen.

THEO. HOLM.

BRIEFER ARTICLES.

New localities.—The following are some localities for plants, not given in Gray's Manual, 6th edition:

Salsola kali tragus was first found and reported in Illinois, by myt self, at Polo, Aug. 14th. Since then I have found it at Oregon, Savanna, and Chicago. Letters to the Experiment Station also give it as occurring at fourteen other places. At most places it was undoubtedly introduced by cattle trains from the north-west. So far it has been found only in the northern part of the state, and chiefly along the railroads. At Savanna, and possibly at some places in Chicago, this plant undoubtedly occurred last year, as two or three thousand plants were found.

Grindelia squarrosa is given as occurring at Evanston only, in this state. Several specimens of this were found by me at Polo, Oregon, and Savanna. These towns are on the Chicago, Burlington and Northern railroad, and the plants were undoubtedly introduced by that road from the north.

At Savanna a few specimens of *Solanum triflorum* were discovered. This is given in the Manual as occurring in central Kansas and westward. This was also introduced by the railroad.

A single specimen of what appears to be *Verbascum nigrum* was found on the Experiment Station grounds at Champaign. This probably came through seed from Europe, as the plant is not given in the Manual as yet occurring in the United States.—G. P. CLINTON, *Champaign, Ills.*

Two Wisconsin Fungi.—Uromyces minimus, n. sp.—Hypophyllous. Uredosori light brown, teleutosori black, oblong or linear, soon naked. Uredospores globose or oval, light brown, echinulate, 12–19μ in diameter, usually 14–16. Teleutospores brown, smooth, spheroidal oval or oblong, 14–22$\times$12–19μ, usually 17–20$\times$15–17μ, apex rounded, conical or occasionally truncate, very strongly thickened, the apical thickening often constituting nearly half the length of the spore; pedicels moderately stout, tinted, once to twice the length of the spore. Colorless clavate paraphyses present.—On *Muhlenbergia sylvatica* Torr. & Gr. Kenosha co., Wisconsin.

In the same station an æcidium occurs on *Cacalia reniformis* Muhl. which differs from the other æcidia on Compositæ and which I have not seen elsewhere, but no experiments have been made to demonstrate genetic relationship.

Doassansia ranunculina, n. sp.—Spots light brown, 2–4^{mm} in diameter, papillate. Sori aggregated or scattered, usually spherical, 100–200μ in diameter, developing in either the parenchyma or the palisade layer of the leaf or in any position in the petiole between the epidermis and the fibro-vascular bundles. Spores crowded, filling the sorus, spherical or polygonal, 6–10μ in diameter. Cortex of one layer of cells which are more or less quadrangular in section, 10–15×8–12μ. Spores germinating in position. Promycelium 3–4μ in diameter, vacuolate. Primary sporidia 6–8 in a whorl on the end of the promycelium, fusiform, vacuolate, 12–20×2–2.5μ. Conjugation by means of a large apical tube both in position and after becoming free. A filament 60–90μ long is then formed from which the secondary sporidia are abstricted in basipetal succession. Secondary sporidia 12–15×2.5–3μ. In material which had germinated and produced the filaments in the field the secondary sporidia conjugated by means of connecting tubes. In many of the specimens collected germination had occurred and the filaments protruded through the cleft cortex and epidermis.

In the leaves and occasionally the petioles of *Ranunculus multifidus* Pursh, in swampy places which had become dry during the summer. Racine, Wisconsin.

Material has been prepared for the distribution of these species in Ellis and Everhart's North American Fungi.—J. J. DAVIS, *Racine, Wisconsin.*

Ruled slides.—For several years I have made much use of ruled slides with a stage microscope. It is so easy thus to measure any thing you dissect, that I wonder they are not in more general use. Those I use are ruled in squares, 10^{mm} each way, in the middle of a slide which ought to be three inches long, and wider than the ordinary slide to prevent getting mixed up with them. The ruling ought to be deep enough so that water will not temporarily make it impossible or very difficult to see the lines. Good ruled slides for the use above named ought to be in the market at moderate prices.—W. J. BEAL, *Agricultural College, Mich.*

CURRENT LITERATURE.

The evolution of plant life.[1]

Another book intended as a University Extension manual has recently come to our notice. In these days when college men are eagerly looking for books suitable for interested intelligent but uninstructed people to read—books which will give a connected idea of plant forms and their activities—any title which promises as much as the above will attract attention. But when attention is directed to the book, few, we think, will be able to detect the appropriateness of the title. Instead of discussing the evolution of plant life the author gives us an account of the various groups of plants, with a single prefatory chapter on life, protoplasm, adaptability, division of labor, the cell, tissues, and similar general matters. The remaining chapters on Mycetozoa, Thallophyta, Lichenes, Characeæ, Muscineæ, Pteridophyta, and Phanerogamia, form essentially a much abbreviated text-book on morphology, whose faults, while chiefly those of abridgement, are too often due to confused ideas of homology.

Mr. Massee's statements are often obscure, and this obscurity appears to be traceable sometimes to his ideas and sometimes to the inappropriate phrases chosen to convey his ideas. The definition of metabolism (p. 41) illustrates the former case, and such a phrase as "protection against climate" (p. 18) the latter. In discussing the evolution of sexuality (p. 66) the author goes far astray. Having mentioned examples of conjugation he adds:

"In these examples the greater part of the protoplasm is used up in the formation of the reproductive bodies; but as differentiation in this direction proceeds, we observe that the relative bulk of the individual specialized for reproductive purposes becomes less and less, until we reach Phanerogams, where *the parts concerned in the process, stamens and ovules, or young unfertilized seeds*, usually bear a very small proportion [*sic*] to the whole; and yet in the fertilized seed we get a concentration of all that is required to evolve, under favorable conditions into an individual like the parent form."

This confusion of ideas regarding sexuality in phanerogams and cryptogams continues throughout the entire book, most strikingly on pp. 68, 69, 74. It is so prominent as to excite some wonderment as to where the writer has been these last ten years. It must have been a spot remote or secluded, for we are assured (p. 74) that "the most

[1] Massee, George:—The evolution of plant life, lower forms. 12 mo. pp. viii, 242 figs. 38. London: Methuen & Co. 1891. 2sh. 6d.

generally accepted primary division of the vegetable kingdom at the present day is into the two divisions formed by Linnaeus" [i. e., Cryptogams and Phanerogams].

With the bulk of the descriptive part of the book less fault can be found; but surely a writer of a university extension manual ought to take the greatest care not to propagate false conceptions of homologies so fundamental as those dealt with above. The book presenting modern views of plant life and adapted to popular reading remains yet to be written in English.

The essential oils.

The chemistry of plant products, as well as their mode of origin, is always a matter of interest to physiologists. When these products are of economic importance, either medicinally or industrially, interest attaches also to their commercial source. Schimmel & Co. of Leipzig and Prag have long made a specialty of one group of such substances, viz., essential oils. A few years ago they established branch laboratories in this country at Garfield, N. J., in the name of their agents, Fritsche Bros., and placed it under the direction of Dr. Frederick B. Power, one of the best known pharmaceutical chemists in this country. Dr. Power has recently compiled a descriptive catalogue of essential oils and organic chemical preparations,[1] which embraces, in a systematic and comprehensive form, and in alphabetical arrangement, not only all the official and ordinary essential oils met with in commerce, but also a large number of rarer products which have been prepared at various times for strictly scientific or experimental purposes. In connection with each article the botanical source, physical characters, and chemical composition are given, with other special tests for purity when such are known.

The work is divided into three parts, comprising (*a*) the official essential oils, or those recognized by the U. S. Pharmacopœia of 1890, together with some closely related oils, (*b*) the non-official essential oils, and (*c*) organic chemical preparations.

The work is concise in its character, contains a considerable number of references to publications embodying the more important original investigations, and the endeavor has been made to present an accurate record, up to the date of publication, of all the well-substantiated facts relating to the characters and composition of the oils and chemical preparations considered in the work.

It is designed for reference chiefly, and will be found useful to all who are either commercially or scientifically interested in the subjects of which it treats.

[1]Small 8vo. pp. 96. New York: Fritsche Bros. $1.00. To be purchased through B. Westermann & Co., New York.

A compendium of general botany.[1]

This book is really a wonder considered from a literary standpoint. It is neat, precise and up to date. One is surprised to find how much has been condensed in so little space. The author has intended it to serve as a guide to the German high school pupils. It ought to serve a similar purpose in this country, but according to the present curriculum of studies it will be found very useful in our colleges and universities.

The arrangement of the subject matter is scientifically correct. Part I, comprising forty-two pages, treats of the cell, part II of tissues and single organs, part III of systems of organs, part IV of reproduction. This is the most interesting part. Here are explained and compared, as in no other textbook, the rotation of gametophytic and sporophytic generations in mosses, vascular cryptogams and phanerogams. Part V treats of the physics and chemistry of plant life, and part VI, comprising six pages, of plant classification.

The author's style is simple yet clear, and scientific. It is not intended as a book for "recreative" reading. The chapter on the general physiology of reproduction is perhaps too deep for the average high school pupil.

The original figures are excellent. The others are well selected from the works of the best authors.—A. SCHNEIDER.

Minor Notices.

THE FOSSIL PLANTS of the Bozeman, Montana, coal fields are listed, with annotations, by Mr. F. H. Knowlton in bulletin 105, U. S. Geological Survey.

PROFESSOR A. S. HITCHCOCK'S "Key to spring flora of Manhattan, [Kansas]" is intended to enable beginners to name the angiosperms of that vicinity.

DIRECTIONS FOR DESCRIBING a flowering plant, i. e., a "scheme for plant analysis", based on Gray's "Lessons," have been prepared by F. L. Sargent and published by the Cambridge Botanical Supply Co.

A LIST OF the Sphagna, parasitic fungi, and liverworts, collected by Mr. L. S. Cheney in the course of the prosecution of a botanical survey of the Wisconsin river valley, has been separately issued in advance of the publication of the tenth volume of the Trans. Wisconsin Academy. The list will accompany the sets of specimens as distributed.

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[1] WESTERMAIER, MAX.—Kompendium der allgemeinen Botanik für Hochschulen. 8vo pp. 309. figs. 171. Freiberg in Breisgau: Herder'sche Verlagshandlung.

EFFECT OF SPRAYING with fungicides on the growth of nursery stock is the subject of a bulletin (no. 7) from the division of vegetable pathology of the U. S. Department of Agriculture. In general much and valuable improvement showed in such plants by application of fungicides, especially of Bordeaux mixture, and particularly with pears, cherries and plums.

THE NINTH NUMBER of the *Minnesota Botanical Studies* contains three articles. Two of them describe newly devised physiological apparatus, and the third is a bibliography of the subject of the fixation of free nitrogen by plants. The last is by D. T. MacDougal, and embraces over 600 titles. It is proposed to issue a second installment of titles after a time. The apparatus has already been mentioned and also advertised in this journal. Both the auxanometer with its continuous recorder, described by the inventor, W. D. Frost, and the registering balance, also described by its inventor, Alex. P. Anderson, are most excellent instruments, and must prove of great service to investigators and to teachers. Both instruments, of which plates from photographs are given, can be bought at a reasonable price.

THE ANNUAL REPORT of the New Jersey Experiment Station for 1893 includes the report of the botanist, Dr. B. D. Halsted, occupying 150 pages, with 73 illustrations. This part has also been distributed as a separate. The number of topics treated by Dr. Halsted is very large. Most of the illustrations are from photographs by the author. Altogether it shows great industry on the part of the writer, and a sharp eye for interesting matters of observation. Most of the report is upon fungous diseases of plants, of which a great variety are treated, many being of the nature of spot diseases.

Only a small part of this report is now published for the first time. The author has brought together in convenient form the result of his labors for the year, reprinting all papers which had previously appeared. We see no reason, however, why the author should not have followed the usual custom of giving credit to the journals to which he is indebted. In some instances this is done, but we notice articles taken from the *American Florist*, the *Proceedings of the Society for the Promotion of Agricultural Science*, and others, for which no credit is given. This is not only an infringement of a well grounded custom, but it makes it difficult for conscientious writers to properly cite such articles.

The report embraces much admirable work, but it must be a regret that bibliographical details were not more carefully looked after.

THE SECTION Harpidium of the genus Hypnum was elaborated for the Muscologia Gallica by Mr. F. Renauld. These pages have been issued as a separate.[1] M. Renauld's wide knowledge of these forms, very careful descriptions, and critical remarks under the more obscure species will be of great assistance to students of this very difficult group.

THE UNCULTIVATED bast fibers of the United States are treated in a bulletin (no. 6) issued by the U. S. Department of Agriculture in its series of fiber investigations. It has been prepared by C. R. Dodge. A score or more of species find place in the list, including the common and well known plants: Hibiscus Moscheutos, Abutilon Avicennæ, Asclepias incarnata, Apocynum cannabinum and others.

IN A preliminary paper on Nucleolen und Centrosomen in the *Berichte* d. deutsch. bot. Gesells. **12**: 108–117. *pl. 6.* 1894,[2] which has been distributed as a separate, Dr. J. E. Humphrey shows that the nucleolus can not be regarded as an organ of the cell, since the extrusion and persistence of nucleolar substance during nuclear division is not normal but exceptional and probably pathological. He thinks the nucleoli inactive globules of fluid or semi-fluid substance. The paranucleolus of Strasburger, a crescentic body found often at one margin of the nucleus, is due to faulty fixation methods. He also finds centrospheres in Psilotum and Osmunda.

WE HAVE received the second edition of the voluminous catalogue of the library attached to the botanical garden of Buitenzorg, Java, of which Dr. Treub is the director. This classified catalogue, arranged under each topic alphabetically by authors, is intended chiefly for the use of the garden staff and visiting botanists. It forms a bulky volume of 371 very large octavo pages (18×26^{cm}). The number of titles is not given, but it may be roughly estimated as between 4,000 and 5,000. A table of contents shows the classification adopted and a full index to authors renders reference very easy. Copies of this catalogue may be obtained gratis by addressing the director.

[1] Musc. Gall. **2**: 368–395. *pl. 105–113.* Mr 1894.
[2] See also Annals of Bot. **8**: 373–375. S 1894.

OPEN LETTERS.

Comment on "The meaning of tree life."

When Professor Greene, in reviewing Professor MacMillan's Metaspermæ of the Minnesota Valley, said that it would prove useful to those who knew how to use it, he can hardly have had reference to the sort of use which appears to have been made of a portion of it by a recent writer in the *American Naturalist.*

In that portion of his work entitled "Relationship of the Metaspermic Flora of the Minnesota Valley," Professor MacMillan has given a careful and elaborate discussion of the causes, past and present, which have determined the character of the region under consideration. In the course of this discussion, he devotes a section to "Outlines of Metaspermic History in the Northern Hemisphere," in which the historical causes determining the present flora of the valley are treated of. The whole of this portion of Professor MacMillan's work, and in particular the section last referred to, seems to have furnished not only the inspiration, but the ideas, and no little of the language of the article in the *Naturalist.*

How far the terms which Professor MacMillan has found to express the phenomena he there discusses have become common property so that they may be used by all without credit, is a question I will not consider. But it would seem that his ideas, if not copyright, are not yet so far in the past that they may be safely drawn on by all comers and used as "raw material" for the "manufactured product" so commonly met with in popular-scientific articles.

By comparing the article entitled "The Meaning of Tree Life" in recent issues of the *Naturalist* with the portions of Professor MacMillan's work referred to above, and also with his note on "Cretaceous Plant-Physiognomy" in the *Naturalist* of April, 1893, it will be perceived that the latter two have furnished the trend and order of argument, a large portion of the ideas, and a considerable portion of the terminology of the former. More than that, a part of it has the air of an ingenious paraphase of Professor MacMillan's work. The style of the *Naturalist* article is, rhetorically, so far removed from ordinary scientific writing, and so much skill in the use of language has been brought to bear upon the paragraphs of the "Metaspermæ," that the influence of the latter is at first scarcely recognizable. But in several places the original is unmistakable. Under such circumstances it may well be asked whether the quotation of one of the most notable sentences of Professor MacMillan's book as the words of a "recent writer" is a sufficient acknowledgment.—ROSCOE POUND, *Lincoln, Neb.*

NOTES AND NEWS.

Dr. A. Zimmermann has been advanced to professor "ausserordentlich" in the University of Tübingen.

The last part of Husnot's Muscologia Gallica was announced for issue in September, and will probably appear shortly.

The European and North American species of Polytrichaceæ are revised by N. C. Kindberg in *Revue Bryologique* 21: 33. 1894.

In *Garden and Forest* (Sept. 12) Mr. J. N. Rose gives an account of the tree Ipomœas of Mexico, describing a new species with illustrations, and also reproducing a capital photograph of a grove of tree Ipomœas.

The announcement by Lord Rayleigh and Professor Ramsey of a new gaseous constituent of the atmosphere, made to the British Association at its last meeting, may prove of much importance to vegetable physiologists.

Professor Geo. F. Atkinson has published in *Bull. Torr. Bot. Club* (August) a preliminary paper on Some Exoasceæ of the United States. Sixteen species or varieties of Exoascus are noted, ten of which are new, and one Taphrina.

Mr. G. Massee is publishing in *Grevillea* revised descriptions of type specimens of fungi in the Kew herbarium, a very useful piece of work since many have been very briefly and imperfectly described. Among them we notice many North American species.

Copies of the Proceedings of the Madison Botanical Congress have been distributed to a large number of botanists, and may be had by those interested on application to the Secretary, Dr. J. C. Arthur, Lafayette, Indiana. Send four cents in stamps for postage.

The difficulties in the cultivation of black pepper in the West Indies have been successfully overcome in Trinidad, as we learn from a bulletin (no. 23) of the Royal Botanic Gardens. A crop of some 200 lbs. has been harvested and samples have received highly satisfactory valuation.

In *Erythea* for August Mr. J. Burt Davy begins the very useful publication of transcripts of descriptions of Californian genera and species from rare publications. This first paper contains genera and species described in the St. Petersburg Imperial Botanic Garden Seed Lists from 1834 to 1844.

Science seems to have been largely absent from the seventh annual meeting of the Association of American Agricultural Colleges and Experiment Stations, judging from the volume of *Proceedings* recently issued. The only reference to botany appears to be two short set of notes by Prof. B. D. Halsted, on Solandi printing and fungi, given in the appendix.

PARTS 106–108 of *Die natürlichen Pflanzenfamilien* have been distributed, containing the completion of Cactaceæ and the Bignoniaceæ by K. Schumann, the Geissolomaceæ, Penæaceæ, Oliniaceæ, Thymelæaceæ, and Elæagnaceæ by E. Gilg; and the Gesneriaceæ and Columelliaceæ by Karl Fritsch.

PROFESSOR JOHN M. COULTER has been appointed "Professorial lecturer" in Botany at the University of Chicago, in charge of the graduate work. This is the beginning of the development of a department of botany which is to be put upon the same footing as the other departments of the university.

THE SEPTEMBER number of the *Forstlich-naturwissenschaftliche Zeitschrift* contains the first installment of a paper entitled: "A contribution to the history of the development of buds in some deciduous trees," by Dr. Paul Albert, together with several other papers of less botanical interest.—L. S. C.

MR. J. M. BATES in some notes on shrubs of Nebraska (Am. Nat. 28, 803) records finding Salix tristis five feet in height, and Salix cordata about twenty feet high and eight inches in diameter. He also states that Œnothera serrulata is occasionally shrubby, two to six inches of ligneous stem surviving the severest winters.

THE LAST *Erythea* (September) announces the purpose of Professor Greene's mission in Europe. He will visit Kew and the great continental herbaria for a critical study of the types of Pacific Coast plants. It is a fortunate thing that Professor Greene can make this study, as no one is so well fitted to make it of lasting value.

GERMAN INVESTIGATORS find that yeast grown upon different substrata, as gypsum blocks and clay tiles, show decided differences in the formation of the spores. Satisfactory comparison with previous work can only be made, when cultures are carried out under the same conditions as the work with which comparison is to be made.

SUR LES Myxobactériacées, nouvel ordre de Schizomycètes, is the title of Dr. Roland Thaxter's paper, which was printed in this journal for December, 1892, as it appears in the *Revue Mycologique* for July, 1894 (pp. 92–108). It was translated by O. J. Richard and R. Ferry. Only about half the figures of the four plates are reproduced.

MR. A. CURTISS, of Jacksonville, Fla., has just sent out lists of 400 Florida plants of his own collection this year, which constitute the first two fascicles of a new distribution of plants of the southern states. Those who remember the beautiful series of seven fascicles distributed by Mr. Curtiss from 1877–1886 will want to have these also.

THE HERBARIUM of the U. S. Department of Agriculture is being removed from the quarters it has so long occupied in the Agricultural Building into the National Museum. This will consolidate what have heretofore been two herbaria, insure safety from fire, making reference more convenient, and give more room to the much crowded Division of Botany.

THE DIVISION of Vegetable Pathology of the U. S. Department of Agriculture is desirous of including physiology within the scope of its labors, very justly maintaining that the best work in pathology is based upon an understanding and development of physiology. It is a departure that all friends of botanical science, in both its pure and applied forms, will be glad to see.

M. LEON GUIGNARD, who first demonstrated the existence of "directive spheres" in plants (Compt. rend. 9 March, 1891) has begun the publication of a series of papers "Sur l'origine des sphères directrices" in *Journal de Botanique* (July 16), called out by subsequent publications. Some botanists seem to have confounded with the directive spheres structures of an entirely different nature.

THE REPORT of the director of the office of experiment stations for 1893, just issued, shows that in the fifty-five stations in the United States there are employed thirty-seven botanists, of which seventeen also give attention to other lines of work. Half of the stations employ no botanist, while only three are without a chemist. Altogether there are three chemists employed to one botanist.

IN THE *Journal of Botany* the description of new tropical African plants continues, among them ten Acanthaceæ (one a new genus, Homilacanthus) by Spencer Le M. Moore, a new tree Senecio by E. G. Baker, and fifteen new Ericaceæ (twelve of which are Ericas) by Harry Bolus. In the May number four new British brambles are described, and in August seven new species of Hieracium!

THE INTERESTING fresh-water alga, which occurs abundantly in the lakes of Minnesota and adjoining states in the form of floating granules of the size of turnip seeds, at first called Rivularia fluitans and afterwards Gloiotrichia Pisum, has been studied by Paul Richter of Leipzig. He calls it *Gloiotrichia echinulata* (Engl. Bot.) P. Richt., and considers it to be a species distinct from the larger form, *Gloiotrichia fluitans* (Cohn).

AN ELABORATE PAPER on our present knowledge of the bacteria by Professor L. H. Pammel is printed in the proceedings of the Iowa Academy of Sciences for 1893. It is the presidential address at the last annual meeting; but what is not common in such cases, it is accompanied by references to the literature from which the statements of facts have been taken, there being no less than 148 citations. It is a mine of facts, and a most valuable résumé.

IN *Bulletin de l'Herbier Boissier* for July, M. Micheli describes six new Leguminosæ from Central America, each illustrated by a beautiful plate; Otto Kuntze gives a set of "Nomenclatur-Studien", in which he fully considers certain recent propositions of Pfitzer in Engler's Jahrbücher, and also those of the Madison Congress (notably priority of place and the law of homonyms); and A. Kasimir discusses the forms of the oxalate crystals of Opuntia and Pereskia. In the August number C. DeCandolle describes some new Meliaceæ from South America.

AS A résumé of a work published in Danish last year[1] M. Rosen-

[1] Groenland's Havalgar. Extr. des Meddelelser om Groenland 3: 763-981. 1893.

vinge publishes, in Ann. d. Sci. Nat. Bot. VII. 19: 53 ff. My 1894, Les algues marines du Groenland. The work is based on the rich collections of the botanical museum at Gopenhagen, which were begun at the end of the eighteenth century by Fabricius, Giesecke, and Wormskiold, and were greatly augmented by Vahl during his eight years sojourn in Greenland, as well as by the abundant contributions of later collectors, including Th. Holm, N. Hartz, and the author. The paper is profusely illustrated by text cuts.

P. Kossowitch has conducted a careful series of experiments in reexamination of the question whether the algæ can fix free nitrogen. He operated with pure cultures of various algæ, obtained in an ingenious way and cultivated in an apparatus of rather complex construction for which the original paper must be consulted.[1] In the entire series of experiments with algæ in pure cultures there was no increase of nitrogen, but when they were mixed with soil bacteria and fungi there was in part a considerable increase of N. Which of the organisms was responsible for this has not yet been determined.

Dr. E. L. Sturtevant has published in *Bull. Torr. Bot. Club* (August) a series of notes on maize, which brings together a very large amount of interesting information. An improved nomenclature for maize is proposed. Taking Z. tunicata as a primitive form, five species are derived, Z. everta (pop corns), Z. indurata (flint corns), Z. indentata (dent corns), Z. amylacea (soft corns), Z. saccharata (sweet corns), and Z. amyleasaccharata (starchy-sweet corns). Each of these five furnished three well-defined sub-species, A, B, and C, dependent on the relation between the diameters of the kernel. All the literature concerning corn and its cultivation has evidently been consulted, but the author considers our data as yet too imperfect to hazard an opinion as to the original locality of maize cultivation.

The University of Minnesota has purchased Dr. J. H. Sandberg's collections and will conduct his uncompleted exchanges according to the accounts as indicated in his ledgers. From this collection some 22,000 plants are directly transferred to the University herbarium. The University will continue the exchange bureau feature and while the transfer may cause some delay in printing the annual list of plants offered, this list will be forthcoming as soon as possible and in the form of preceding lists. The University of Minnesota has also acquired a collection of 6,500 plants from Mr. G. B. Aiton, a well known and expert collector of western American plants, and some foreign sets of importance. The herbarium is estimated to contain about 140,000 specimens at the present time and is growing rapidly.

Recent station bulletins having botanical character are as follows: The Russian thistle is treated by W. M. Hays (Minn. no. 33) from the economic side. Three half-tone illustrations and dissections of the flower give a good idea of the plant. Nevada weeds are discussed by F. H. Hillman (Nev. no. 22). The present bulletin treats of Hordeum jubatum, Franseria Hookeriana, Iva axillaris, Capsella

[1] Untersuchungen über die Frage, ob die Algen freien Stickstoff fixiren. Bot. Zeitung **52**: 97–116. 16 My 1894.

Bursa-pastoris, and Lepidium intermedium. A sprig and some seeds of each kind of weed are glued to the pages, and with some plates serve as excellent illustrations. An elaborate study of cotton fiber and of its improvement by crossing is given by P. H. Mell (Ala. no. 56). An interesting account of cultivated poplars (Cornell, no. 68) and of native dwarf cherries (Cornell, no. 70) is given by L. H. Bailey, both being unusually well illustrated. Twelve species of poplar and a number of varieties and three species of cherries are described. The latter include a new species, Prunus Besseyi, and a hybrid of P. Besseyi and P. Watsoni. Crown knot, a disease of fruit trees of unknown origin is treated by J. W. Toumey (Ariz. 2, no. 1.

RESEARCHES ON the structure of the Terebinthaceæ by M. Jadin,[1] embracing an examination of 207 species distributed through sixty-seven of the seventy-one genera, show that the stem is always characterized by the secretion canals developed in the phloem and protected by "pericyclic" fibers. This feature is so constant that it seems to be the most important character of the family. The characters furnished by the stem do not suffice to distinguish the genera, though in some cases they may be used to supplement the external morphology. The absence of medullary canals is constant in some genera; their presence is constant in others; and again in some they are either present or absent, for which fact no satisfactory explanation was discovered.

MR. E. BELZUNG calls attention to an important discovery in relation to the rôle of calcium oxalate, viz., its existence in the embryos of papilionaceous Leguminosæ in a state of solution or, more exactly, loose combination with the free acids of the cell sap, e. g., as citroxalate or oxoxalate of calcium. This is independent of the visible, partly crystalline, partly granular, calcium oxalate, and is prepared to play the rôle of a nutritive reserve. Since oxalate of calcium may exist in considerable quantity exclusively in a dissolved state, the determination of the absence of crystals of this salt is not sufficient ground for predicating its absence in any given species. Lupinus luteus, for example, has the oxalate crystals in its cotyledons, while in the same organs of L. albus it is all in the dissolved state. But both have crystals in the internal fibrous layer of the hard pericarp. Here however the precipitation of the oxalate is connected with the lignification of the cell walls and is brought about by the resorption of the cell contents, so that it must be looked upon as a product of cellular inanition and not a principle which again participates in normal life.

S. NAWASCHIN contributes to the *Berichte* der deutschen botanischen Gesellschaft,[2] a preliminary account of his researches on the embryology of the Betulaceae. He claims to have priority over Miss Margaret Benson's publication regarding the chlazogamic fertilization in these plants (see this journal 19: 299. Jy 1894).

In the present paper he summarizes his conclusions regarding the birches and alders. He finds that the fundament (*Anlage*) of the flower is formed of an axillary shoot whose apex is concealed in the

[1] Ann. d. Sci. Nat. Bot. VIII. **18:** 151. My 1-894.

[2] Kurzer Bericht meiner fortgesetzen Studien über die Embryologie der Betulineen. l. c., **12:** 163-169. 31 Ag 1894.

depression between the two carpellary leaves. The two stigmas and the style canal are developed from these carpels later, whereas much the greater part of the ovary is produced by later intercalary growth of the floral axis. The *anlage* of the ovules appear as lateral swellings of the floral axis which grows to form the wall of the ovary; and the alteration produced by the intercalary growth of the axis is such as to make these ovules appear to be upon the margin of the carpels, while in fact they are situated upon an axile placenta which is a columnar prolongation of the axis, and are homologues of leaves. The ovary even at maturity is not closed, the style canal being open; the pollen tube, however, does not pass through it, but penetrates the tissues of the swollen margins of the carpels, of the upper part of the placenta, of the funiculus, and finally of the chalaza, reaching by this route the apex of the embryo sac. Here it broadens irregularly and sends out a number of long outgrowths which not rarely surround the embryo sac from apex to base. The antipodal cells and egg apparatus are as usual, but the two remaining nuclei do not fuse until fertilization proper occurs.

Three stages are marked in this course of development: first, before pollination the ovary is undeveloped, the flower axis has formed the two first leaves (carpels) and its apex forms a yet simple axile placenta; second, at the time of pollination the two carpels have reached their full development, constituting two stigmas and a short style canal, and the axis is forming the next pair of leaves as the ovular anlage; third, at the time of fertilization the carpels are long since dried, the ovary has been fully formed and the ovules have just reached their full development.

Nawaschin concluded that there must be an intermediate type between the chlazogamous and porogamus angiosperms and has discovered it in the Ulmaceae. At the time of pollination the ovules are almost ripe; the pollen tube passes through the short style and descends the funiculus half the length of the ovule and then directs itself to the apex of the nucellus which it reaches by penetrating both integuments!

In discussing briefly the evolution of the ovule and fertilization Nawaschin holds with Agardh that the so-called gymnospermous ovule is to be looked upon as an ovary, the nucellus being an axile placenta containing an ovule limited to the embryo sac (the so-called corpuscula).

BOTANICAL GAZETTE, 1894. PLATE XXXI.

☞Subscribers are requested to forward no subscriptions for the Botanical Gazette through the READERS UNION PUBLISHING CO., of Lansing, Michigan. We shall have no further dealings with this concern.

PUBLISHERS.

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[Entered at the Post-office at Madison, Wis., as second-class postal matter.]

In the December number will appear:

A contribution to the comparative histology of pulvini and the resulting photeolic movements, by FRED DE FOREST HEALD, *Fellow in Botany, University of Wisconsin.*

Two new ferns from New England, by GEORGE E. DAVENPORT, *Medford, Mass.*

Some notes on the Leguminosæ of Siam, by PROF. GLENN CULBERTSON, *Hanover College, Hanover, Ind.*

Noteworthy anatomical and physiological researches.

Index and table of contents of Vol. XIX *will be issued with this number.*

BOTANICAL GAZETTE

NOVEMBER, 1894.

Popular American plant-names. III.

FANNIE D. BERGEN.

[Reprinted by request from plates kindly furnished by the editor of the *Journal of American Folk-lore*.—EDS.]

IN this paper the writer has, for convenience, discarded the systematic arrangement of names of genera, under families, and adopted the alphabetical arrangement. It has also seemed best, in view of the threatened revolution in nomenclature, to give the authorities for the scientific names used, as far as these could be conveniently ascertained. In a few instances the Spanish names of species (mainly of the Pacific coast region) have been given, but it has been the writer's intention to insert these only when they are commonly current among English-speaking people as well as among the Mexicans.

UMBELLIFERÆ.

Angelica, sp., Aunt Jerichos, N. E.
Daucus Carota, L., Queen Anne's lace, somewhat general.
bird's nest, N. J.
lace-flower,[1] Philadelphia, Pa.
Devil's plague,[1] West Va.
Erigenia bulbosa, Nutt., turkey-pea,[2] near Cincinnati, O., fifty years ago.

Pastinaca sativa, L., queen-weed, West Va.

ARALIACEÆ.

Aralia hispida, Vent., pigeon-berry, Buckfield, Me.
Aralia nudicaulis, L., sassafariller, Banner Elk, N. C.
Aralia quinquefolia, Decaisne & Planch., sang,[3] West Va.
ginshang, Vt.
Aralia racemosa, L., spice-bush, Hartford, Conn.

[1] The former evidently a city-born name, the latter from the point of view of the farmer, who finds the species a pestilent weed.
[2] Name given in a former list, but without locality.
[3] Evidently an abbreviation for ginseng.

Aralia racemosa, L., life-o'-man, Fryeburg, Me.
old man's root, Buckfield, Me.
spignet, Banner Elk, N. C.

CORNACEÆ.

Cornus florida, L., nature's mistake, Abington, Mass., about fifty years ago.

Cornus stolonifera, Michx., squaw-bush,[1] Penobscot Co., Me.

Nyssa sylvatica, Marsh., horn-bine, horn-pine, Southern States.
old man's beard, Lincolnton, N. C.

Linnæa borealis, L., deer-vine, Me.

Lonicera Tatarica, L., "twin sisters," La Crosse, Wis.

Symphoricarpus occidentalis, Hook., wolf-berry, buck-brush, W. Neb.

Symphoricarpus racemosus, Michx., waxberry, N. Y.

Viburnum lantanoides, Michx., moose-berry, triptoe,[2] hobble-bush,[2] Franconia, N. H.
tangle-foot,[2] N. H.
moose-bush, Buckfield, Me.

Viburnum nudum, L., nanny-berry, West Va., Livingston Co., N. Y., Ferrisburgh, Vt.
possum-berry, Ocean Springs, Miss.

Viburnum lentago, L., wild raisin, Penobscot Co., Me.

RUBIACEÆ.

Cephalanthus occidentalis, L., pond buttonwood, crouper-bush. Ferrisburgh, Vt.

Galium Mollugo, L. (and other sp.), mist, babies' breath, E. Mass.

Houstonia cærulea, L., eye-bright, W. Maine, Cambridge, Mass.
starlights, Cambridge.
Venus's pride, Stonington, Conn.

DIPSACEÆ.

Dipsacus sylvestris, Mill., Indian thistle, Huttonweed,[3] English thistle, water-thistle,[4] West Va.

COMPOSITÆ.

Actinomeris squarrosa, Nutt., wing-stem, stickweed, West Va.

Ambrosia Artemisiæfolia, L., bitterweed, N. Y., Neb.

Anaphalis margaritacea, Benth. & Hook., poverty-weed, Penobscot Co., Me.

[1] The bark is said to have been smoked by the Indians for tobacco.

[2] From the fact that the branches often take root at the ends.

[3] Because found on the farm of a man named Hutton.

[4] From the amount of water often found in the concavity of the leaves next the stem.

Antennaria plantaginifolia, Hook., pincushions, Hingham, Mass.
dog-toes, Concord, Mass.
splinter-weed,[1] Peoria, Ill.

Anthemis Cotula, D. C., stinking chamomile, N. Y.

Artemisia Absinthium, L., boys' love,[2] Wellfleet, Mass.

Artemisia Abrotanum, L., sweet Benjamin, Concord, Mass.

Artemisia Ludoviciana, Nutt., sage, Minn.

Artemisia tridentata, Nutt., sage-brush, Neb., Rocky Mountain region.

Aster cordifolius, L., var. *lævigatus*, Blue Devil, stick-weed, bee-weed, Fall Aster, West Va.

Aster diffusus, Ait., var. *hirsuticaulis*, Gray, white devil, wire-weed, devil-weed, Old Virginia stick-weed, old-field-sweet, farewell-summer, nail-rod, West Va.

Asters of any kind, Michaelmas daisies, N. Y.

Asters of any species, it-brings-the-frost, Onondaga Indians, N. Y.

Aster (a purple species), Good-by Summer, Lincolnton, N. C.

Baccharis halimifolia, L., ploughman's spikenard, N. Y.

Baccharis viminea, D. C., black willow, Santa Barbara Co., Cal.

Bidens frondosa, L., cuckles,[3] Concord, Mass.
Devil's pitchfork, Ferrisburgh, Vt., Concord, Mass.

Bidens, sp., stick-tights, N. Y.

Cacalia, sp., Indian plantain, West Va.

Centaurea benedicta, L., sweet sultan, Mattapoisett, Mass.

Centaurea, sp., dusty miller, Boston Florists' catalogue.

Chondrilla juncea, L., skeleton weed, naked weed, hog bite, Devil's grass, West Va.

Chrysanthemum leucanthemum, L., Kellup weed, Rhode Island clover, Montpelier, Vt.
bullseye, Me., Andover, N. B., West Va.
bullseye daisy, Andover, N. B.
sheriff pink, West Va.

Chrysanthemum parthenioides, hort., double feverfew, double feather-few, camphor geranium, bridal roses, West. Mass.

Cichorium Intybus, L., bachelor's button, Mass., So. Cal.

[1] Name used by a few children, from the appearance of the heads.

[2] Has this name been given because the plant was confounded with *Artemisia Abrotanum*?

[3] A corruption of cockles. This may be "the *Cuckold*, a troublesome weed in plough-lands, whose seeds have horns" mentioned in Williamson's *History of Maine*, 1832.

Cnicus arvensis, Hoffm., Canada thistle, E. Neb.
Cnicus lanceolatus, Hoffm., boar thistle, West Va.
Coreopsis, sp., old maid's breastpin, Plymouth, O.
dye-flowers, Banner Elk, N. C.
Elephantus tomentosus, L., tobacco weed, Devil's grandmother, W. Va.
Eupatorium ageratoides, L., richweed, Banner Elk, N. C.
Eupatorium cœlestinum, L., mist-flower, blue boneset, West Va.
Eupatorium purpureum, L., quill-wort, Indian gravel root,[1] West Va.
nigger-weed, queen-of-the-meadow, Ind.
marsh milk-weed, Mass.
Fransenia Hookeriana, Nutt., sand-bur, Cal.
Gnaphalium polycephalum, Michx., Indian posy, Stonington, Ct.
moonshine, Dorset, Vt.
balsam, N. Y.
rabbit-tobacco, N. C.
Grindelia robusta, Nutt., gum-plant, Cal.
Hemizonia pungens, T. & G., tar-weed, Cal.
Hieracium aurantiacum, L., Flora's paint brush, Oxford Co. and Penobscot Co., Me.
Iva frutescens, L., Jesuit's bark, N. Y.
Krigia amplexicaulis, Nutt., False dandelion, W. Va.
Lactuca Canadensis, L., Horse-weed, Devil's iron-weed, Devil's weed, West Va.
Lactuca integrifolia, Bigel., Devil's iron weed, W. Va.
Leontodon autumnalis, L., arnica bud, dog dandelion, Allston, Mass.
Liatris scariosa, Willd., Devil's bite,[2] Concord, Mass.
Madia sativa, Molina, tar-weed, Berkeley, Cal.
Matricaria discoidea, D. C., wild marigold, Col. Springs, Cal.
Porophyllum gracile, Benth., poison flower, Colorado River.
Prenanthes altissima, L., bird-bell, N. Y.
Parthenium integrifolium, L., wild quinine, W. Ind.
Rudbeckia hirta, L., brown daisy, Concord, Mass.
ox-eye daisy, somewhat general in Mass.
Brown Betty, Passaic, N. J.
Rudbeckia triloba, L., nigger-heads, Anderson, Ind.
Senecio aureus, L., snake-root,[3] Concord, Mass.
Solidago, sp., yellow-weed, Vt.
Solidago bicolor, L., silver-weed, N. Y.
Solidago, sp., pyramid golden-rod, N. Y.
Tragopogon porrifolius, L., nap-at-noon, Hennepin, Ill.
Tussilago Farfara, L., ginger-root, Minn.

[1] Apparently thought to be a remedy for calculi.
[2] Because the corm or tuber is thought to look as if bitten off.
[3] From the aromatic and bitterish flavor of the roots, like that of *Polygala Senega*.

LOBELIACEÆ.

Lobelia cardinalis, L., hog physic, Plymouth Co., Mass.
red Betty, Ferrisburgh, Vt.
Lobelia Dortmanna, L., water gladiole, N. Y.
Lobelia inflata, L., low belia.[1]
Lobelia syphilitica, L., high belia.[1]

ERICACEÆ.

Andromeda ligustrina, Muhl., seedy buckberry, West Va.
Arbutus Menziesii, Pursh, madroño, Cal.
Arctostaphylos glauca, Lindl., manzanita, Cal.
Arctostaphylos Uva-ursi, Spreng., hog-cranberry, Provincetown, Mass.
mountain cranberry, Southern Me.
Chimaphila umbellata, Nutt., wintergreen, Buckfield, Me., Penobscot Co., Me.
Chiogenes serpyllifolia, Salisb., running birch, Vt.
moxie berry, Penobscot Co., Me.
Gaultheria procumbens, L., partridge-berry, N. H.
partridge-plant, N. Y.
chickaberry, Stonington, Ct.
(young leaves) { young come-ups, Ferrisburgh, Vt.
little Johnnies, Calais, Me.
Gaultheria Shallon, Pursh, salad, Cal.
Gaylussaccia resinosa, Torr. & Gr., black snaps, Wells, Me.
Kalmia angustifolia, L., ivy, Va.
Kalmia latifolia, L., ivy, N. C.
Ledum latifolium, Ait., Labrador, Buckfield, Me.
Leucothoe, sp., hemlock, N. C.
Monotrapa uniflora, L., Dutchman's pipe, N. J.
fairy smoke, Deering, Me.
Pyrola elliptica, Nutt., wild lily-of-the-valley, Concord, Mass.
Rhododendron maximum, L., cow-plant, Montpelier, Vt.
horse-laurel, White Haven, Pa.
Rhododendron, all species, laurel, N. C.
Rhododendron nudiflorum, Torr., wild honeysuckle, Georgia, W. Va.
Mayflower, N. J.
Rhododendron viscosum, Torr., swamp honeysuckle, Concord, Mass., Boxford, Mass.
white honeysuckle, Ala.
Rhododendron viscosum, Torr., var. *glaucum*, Gray, cinnamon honeysuckle, West Va.
Sarcodes sanguinea, Torr., snow-plant, Cal.

[1] Somewhat general among herb-collectors.

Vaccinium hirsutum, Buckley, bear-huckleberry, N. C.
Vaccinium Pennsylvanicum, Lam., strawberry-huckleberries, Weymouth, Mass.

DIAPENSIACEÆ.

Galax aphylla, L., coltsfoot, Banner Elk, N. C.

PRIMULACEÆ.

Dodecatheon Meadia, L., Indian chief, Rockford, Ill.
Johnny jump, So. Cal.
Dodecatheon Meadia, var. shooting stars, roosters' heads, Santa Barbara Co., Cal.
Lysimachia nummularia, L., down-hill-of-life, Lincolnton, N. C.
Lysimachia stricta (?) Ait., swamp candles, N. E.
Trientalis Americana, Pursh, star-anemone, Concord, Mass.
May-star, N. Y.
Star-of-Bethlehem, E. Mass.

STYRACACEÆ.

Halesia tetraptera, L., shittimwood, West Va.
Symplocos tinctoria, L'Her., dye-leaves, Banner Elk, N. C.

OLEACEÆ.

Osmanthus Americana, Benth. & Hook., devil-wood, Ala.

APOCYNACEÆ.

Apocynum androsæmifolium, L., rheumatism-weed, West Va.
Macrosiphonia brachysiphon, Gray, jessamine, Arizona.

ASCLEPIADACEÆ.

Asclepias cornuti, Decaisne, wild cotton, West Va.
Asclepias tuberosa, L., white root, Mass.
Archangel, (near) Providence, R. I.

GENTIANACEÆ.

Erythræa Muhlenbergii, Griseb., conchalagua, Cal.
Eustoma Russelianum, Griseb., Canada pest, Deer Lodge, Mont.
Gentiana Andrewsii, Griseb., bottle-gentian, barrel-gentian, Concord, Mass.
blind-gentian, N. E.
Sabbatia angularis, Pursh, pink bloom, West Va.

HYDROPHYLLACEÆ.

Eriodictyon glutinosum, Benth., palo santo, yerba santa, Cal.
Nemophila insignis, Dougl., baby-blue-eyes, blue-bells, Santa Barbara Co., Cal.

BORRAGINACEÆ.

Cynoglossum, sp., stick-seed, dog-bur, wool-mat, West Va.
Cyonglossum officinale, L., dog-bur, West Va.
stick-tights, Anderson, Ind.
tory-bur,[1] N. Y.
Echinospermum Lappula, Lehm., *E. Redkowskii*, Lehm., var. *occidentale*, Watson, *E. Virginicum*, Lehm., stick-tight, Minn.
Echinospermum Virginicum, stick-tights, Anderson, Ind.
Echium vulgare, L., blue thistle, blue weed, blue stem, West Va.
blue thistle, Va., N. Y.
blue devils, blue weed, Iowa.
Krynitzkia, sp., Fischer & Meyer, white forget-me-nots, Santa Barbara Co., Cal.
Lithospermum canescens, Lehm., Indian paint, Minn.

CONVOLVULACEÆ.

Convolvulus sepium, L., woodbine, N. Y.
Cuscuta compacta, Juss., love-vine,[2] Banner Elk, N. C.
Cuscuta racemosa, Mart., alfalfa dodder, Cal.
Ipomœa pandurata, Meyer, wild sweet potato, West Va.
mechoacanna, N. Y.

SOLANACEÆ.

Datura Stramonium, L., stinkweed, West Va.; Jamestown lily, Lincolnton, N. C.
Datura Tatula, L., Jamestown lily, Lincolnton, N. C.
Lycium vulgare, Dunal., box-thorn, bastard jasmine, Iowa.
Nicotiana Bigelovii, Watson, wild tobacco, Santa Barbara Co., Cal.
Nicotiana glauca, Graham, tree tobacco, Santa Barbara Co., Cal.
Nicotiana rustica, L., Indian tobacco, real tobacco, N. Y.
Physalis, sp., wild cherry, N. J.
Physalis grandiflora, Hook., wild tomato, No. Minn.
Physalis Virginiana, Mill., wild cherry, No. Minn.
Solanum Carolinense, L., sand-brier, radical, West Va.
bull-nettle, Perrysville, Ind.
Solanum rostratum, Dunal., buffalo-bur, So. Neb.

SCROPHULARIACEÆ.

Calceolaria corymbosa, Ruiz. & Par., lady's slipper, Hopkinton, Iowa.
Castillea coccinea, Spreng., bloody warrior, Minn.
nosebleed, Conn.

[1] Name perhaps now obsolete.
[2] Probably because used in love-divinations.

Castillea coccinea, Spreng., Indian pink, Peoria, Ill.
Chelone, sp., snake-mouths, Banner Elk, N. C.
Collinsia verna, Nutt., blue-eyed Marys, Anderson, Ind.
Linaria vulgaris, Mill., wild flax, devil's flax, wild tobacco, Indian hemp, impudent lawyer, West Va.
snap-dragon, Cambridge, Mass.
Veronica Americana, Schweinitz, blue-bells,[1] Fort Fairfield, Me.
wallink, West Va.
Veronica officinalis, L., gypsy-weed, West Va.

BIGNONIACEÆ.

Catalpa Bignonioides, Walt., catawba, West Va.

PEDALIACEÆ.

Martynia proboscidea, Glox., pickled rats,[2] N. Y.

VERBENACEÆ.

Lantana, sp., tea-plant, Louisiana.
Verbena hastata, L., iron-weed, Jones Co., Iowa.

LABIATÆ.

Audibertia polystachya, Benth., grease-wood,[3] So. Cal.
Brunella vulgaris, L., blue curls, somewhat general.
dragon-head, Deer Lodge, Mont.
Coleus Blumei, Benth., Joseph's coat, general.
Conradina canescens, Gray, wild rosemary, Fla.
Isanthus cœruleus, Michx., flux-weed, New Albany, Ind.
Lamium amplexicaule, L., hen-bit, Iowa.
Melissa officinalis, L., lemon-balm, common balm, sweet Mary, lemon-lobelia (pronounced lobely), N. E.
goose-tongue, Concord, Mass.
Monarda, sp., sweet Mary, N. H.
Nepeta Glechoma, Benth., Gill-run-over-the-ground, Conn.
Pycnanthemum lanceolatum, Pursh, pennyroyal, Minn.
Salvia Ballotæflora, Benth., majorano, Texas and adjacent Mexico.
Scutellaria lateriflora, L., mad-dog-skull-cap, West Va.

PLANTAGINACEÆ.

Plantago lanceolata, L., buck-plantain, buck-horn plantain, ripple, ribwort, English plantain, West Va.
Plantago Rugelii, Decaisne, silk-plant, Fla.

[1] The stigma is said to form the clapper.
[2] Name apparently transferred from the fruit, as seen pickled, to the entire plant.
[3] One of the shrubs so called.

AMARANTACEÆ.

Amarantus salicifolius, hort., fountain-plant,[1] Boston florists' catalogue.

CHENOPODIACEÆ.

Chenopodium Botrys, L., ambrosia, Concord, Mass.
Chenopodium Capitatum, Watson, Indian paint,[2] Colorado, Tobique River, New Brunswick.
Salsola Kali, L., Russian thistle, No. Neb.
Salsola Kali, var. *Tragus*, Moguin, Russian thistle, Russian cactus, Dak.
Sarcobatus vermiculatus, Torr., greasewood, Neb.

POLYGONACEÆ.

Polygonella articulata, Meisn., sand-grass, Wellfleet, Mass.
Polygonum orientale, L., gentleman's cane,[3] Mansfield, O.
Polygonum Persicaria, L., heartsease,[4] Eastport, Me., Mansfield, O.
heart-weed,[4] Penobscot Co., Me.
black heart,[4] So. Vt.
Polygonum amphibinum, L., var. *terrestre*, Leers., heartsease,[5] Neb.
Rumex acetosella, L., horse-sorrel, Minn.
red sorrel, red weed, West Va.
sour grass, Hartford, Conn.

ARISTOLOCHIACEÆ.

Asarum arifolium, Michx., heart-leaves, Ga.
Asarum Virginicum, L., heart-leaves, Banner Elk, N. C.
Asarum Canadense, L., coltsfoot, N. Y.
colic-root, West Va.

LAURACEÆ.

Persea Carolinensis, Nees., red bay, Ala., N. C.
white bay, N. C.
Umbellularia Californica, Nutt., California olive, California laurel, cajeput, Cal.

THYMELEACEÆ.

Dirca palustris, L., wicopy,[6] Penobscot Co., Me.

[1] From drooping habit of foliage.
[2] Because of the bright color of the fruit.
[3] The stems cut by children into canes.
[4] From the shape of the dark spots on the leaves.
[5] A name also applied in the same localities to *P. Pennsylvanica* and *P. Persicaria*,—used very generally by bee-keepers.
[6] An Indian name.

ELEAGNACEÆ.

Shepherdia argentea, Nutt., buffalo-berry, Upper Missouri.

EUPHORBIACEÆ.

Croton monanthogynus, L. (?), prairie tea,[1] common from the Gila to the Rio Grande.

Eremocarpus setigerus, Benth., turkey mullein, Santa Barbara Co., Cal.

Euphorbia Cyparissias, L., balsam, Mooers, N. Y.
graveyard-weed, West Va.

Euphorbia Lathyris, L., mole-weed, West Va.

Simmondsia, sp., "supposed to be the quinine plant," So. Arizona.

Stillingia Sylvatica, L., queen's delight (corrupted into "queen of the lights"), Ga.

URTICACEÆ.

Broussonetia papyrifera, Vent., cut paper, West Va.

Celtis occidentalis, L., hoop-ash, beaver-wood, N. Y.

Maclura aurantiaca, Nutt., wild orange, N. J.

PLATANACEÆ.

Platanus occidentalis, L., button-ball, N. J.

JUGLANDACEÆ.

Carya alba, Nutt., kiskytom, Otsego Co., N. Y.
king-nut, West Va.
walnut, N. E., Minn.

MYRICACEÆ.

Myrica Gale, L., meadow-fern, Dover, Me.

CUPULIFERÆ.

Betula glandulosa, Michx., scrub birch, Mich.

Betula lenta, L., cherry birch, Canada.

Betula papyrifera, Marshall, spool-wood, N. H.

Betula populifolia, Ait., pin-birch,[2] Penobscot Co., Me.

Betula pumila, L., tag alder, Minn.

Carpinus Caroliniana, Walter, iron-wood,[3] Ky.

[1] Used as tea.

[2] A name given especially to the young trees, an inch or more in diameter, which are cut into hoop-poles, etc.

[3] *Ostrya Virginica*, which in Gray's *Manual* is also called iron-wood, is in Kentucky known only as hop-hornbeam or lever-wood. This nomenclature is also that of Wood's *Botany*, and, I fancy, may be the usual one.

Fagus sylvatica, L., white beech, red beech, N. Y.
Ostrya Virginica, Willd., hardhack, Franconia, N. H.
Quercus agrifolia, Nee., scrub oak, evergreen oak, Cal.
encino (Mexicans), Cal.
Quercus Catesbæi, Michx., forked-leaved black jack, S. C.
Quercus chrysolepis, Liebm., Californian live oak, Cal.
Quercus cinerea, Michx., blue jack, S. C.
Quercus lobata, Nee., Roble (Mexicans), Cal.
Quercus oblongifolia, Torr., evergreen white oak, live oak, Cal.
Quercus stellata, Wang., iron oak, West Va.
Quercus Wislizeni, A. De C., var. *frutescens*, Engelm., desert oak, S. E. Cal.

SALICACEÆ.

Populus tremuloides, Michx., quaking asp, Mansfield, O., N. E., Iowa.
Salix, sp. (any of those with large catkins, when buds are opening), pussy-willows, U. S.
goslings, Franklin Centre, P. Q.

EMPETRACEÆ.

Corema Conradii, Torr., poverty-grass, Provincetown, Mass.
Empetrum nigrum, L., hog cranberry, Islands of Penobscot Bay, Me.

CONIFERÆ.[1]

Abies balsamea, Miller, blister pine, balm of Gilead fir, West Va.
Abies Douglasii, Oregon pine,[2] San Francisco, Cal.
Chamæcyparis Lawsoniana, Parlat., Oregon cedar, white cedar, ginger-pine, Oregon and No. Cal.
Chamæcyparis Nutkaensis, Spach, Alaska cedar, Washington.
yellow cedar, Alaska.
Cupressus Guadalupensis, Watson, blue cypress, Cal.
Cupressus macrocarpa, Hartw., Monterey cypress, So. Cal.
Juniperus tetragona, Schlecht., sweet-berried cedar, New Mex.
Larix Americana, Michx., cypress, Buckfield, Me.
juniper,[3] Penobscot Co., Me., Grand Lake region of Penobscot River, Me.
Libocedrus decurrens, Torr., white cedar, Cal.
Picea alba, Link, cat-pine, Buckfield, Me.
skunk-spruce,[4] Mt. Desert, Me., Washington Co., Me., Islands of Penobscot Bay, Me.

[1] Most of the names of Rocky Mountain and Pacific Coast *Coniferæ* in the present paper were contributed by Mr. J. A. Allen, of the Gray Herbarium.
[2] Called spruce in some regions, hemlock in others.
[3] Hardly ever called by any other name.
[4] From supposed unpleasant smell of foliage.

Picea nigra, Link, cat-spruce, Penobscot Co., Me.
yew-pine, spruce-pine, West Va.
Pinus Banksiana, Lambert, jack-pine, Mich. and Minn.
shore-pine, rock-pine, Grand Lake section of Penobscot River.
the unlucky tree,[1] Adirondacks.
Pinus brachyptera, Engelm., yellow pine,[2] Cal. and New Mex.
Pinus edulis, Engelm., piñon (Mexicans), nut-pine of New Mex., or simply nut-pine (Americans), Tex. to Cal.
Pinus Lambertiana, Dougl., sugar-pine, Cal.
Pinus ponderosa, Dougl., yellow pine, Cal.
Pinus ponderosa, var. *scopulorum*, Engelm., bull-pine, Black Hills.
Pinus resinosa, Ait., Norway pine, Washington Co., Me., Minn.
Pseudotsuga Douglasii, Carr., Oregon pine, San Francisco, Cal.
Taxus Canadensis, Willd., creeping hemlock, West Va.
Thuya occidentalis, L., white cedar, Minn.
cedar,[3] Penobscot Co., Me.
Torreya Californica, Torr., nutmeg-tree, Cal.

ORCHIDACEÆ.

Arethusa bulbosa, L., wild pink, Atlantic City, N. J.
laughing jackass (locality ?).
Calopogon, sp., grass pink, Fla.
Corallorhiza, sp., crawley, N. C.
Corallorhiza multiflora, Nutt., dragons' claws, N. Y.
Cypripedium, any sp., ducks,[4] Wyoming Valley, Pa.
Cypripedium, sp., whip-poor-will shoe (Indians), N. Y.
Cypripedium acaule, Ait., valerian,[5] Franconia, N. H.
whip-poor-will's shoes, squirrels' shoes, Conn.
Goodyera pubescens, R. Br., ratsbane, Banner Elk, N. C.
Habenaria orbiculata, Torrey, Solomon's seal, Vt.
Habenaria psycodes, Gray, soldier's plume, N. Y.
Orchis spectabilis, L., purple orchis, N. Y.
Spiranthes, sp., ladies' tresses, ladies' dresses, ladies' traces (the latter two corruptions) (locality ?).
Spiranthes, sp., spiral orchid, N. H.

[1] It is believed that some calamity will befall whoever stands under this pine, and that it is especially unlucky for women to do so.

[2] Called pitch-pine in some regions.

[3] Never called by any other name.

[4] When the flower is partly filled with sand and set afloat on water, it looks like a duck.

[5] Probably on account of its supposed efficacy as a cure for nervous disorders. The plant has a wide reputation as a remedy in such cases.

Spiranthes cernua (?), Richard., screw-auger, Nova Scotia.
Spiranthes gracilis, Bigelow, twisted stalk, West Va.

IRIDACEÆ.

Gladiolus, sp., sword lily, N. Y.
Jacob's ladder, Lincolnton, N. C.
Iris prismatica, Pursh, } poison flag-root, Concord, Mass.
Iris versicolor, L., }
Sisyrinchium angustifolium, Mill., blue-grass, grass-flower, star-eyed grass, Concord, Mass. (children).

AMARYLLIDACEÆ.

Agave, sp., Indian maguey, New Mex.
Agave Virginica, L., rattlesnake's master, S. C.
Narcissus Poeticus, L., } Easter flowers,[1] Lincolnton, N. C.
Narcissus Pseudo-narcissus, L., }
Narcissus Pseudo-narcissus, L., butter and eggs, Martha's Vineyard, Mass.
Zephyranthes Atamasco, Herb., Easter lily, Macon, Ga.

DIOSCOREACEÆ.

Dioscorea villosa, L., colic-root, West Va.

LILIACEÆ.

Allium, sp., ramps, Banner Elk, N. C.
Allium Schœnoprasum, L., shore onion, Andover, N. B.
Allium tricoccum, Ait., ramps, West Va.
Amianthium muscætoxicum, Gray, crow-poison, Banner Elk, N. C.
Brodiæa capitata, Benth., hog onion,[2] Spanish lily, Santa Barbara Co., Cal.
Calochortus (several species), Mariposa lilies, Santa Barbara Co., Cal.
Calochortus Nuttallii, T. & G., Mariposa lily, Deer Lodge, Mont.
Clintonia borealis, Raf., dogberry, Bath, Me.
bear-plum, Franconia, N. H.
Northern lily, Penobscot Co., Me.
wild corn, Oxford Co., Me.
wild lily-of-the-valley, Concord, Mass.
Erythronium albidum, Nutt., } Deer's tongue, Anderson, Ind.
Erythronium Americanum, Ker., }
Erythronium albidum, lily, Peoria, Ill.
Erythronium Americanum, trout-flower (local), N. Y.

[1] Name also applied to Ranunculus and many early species of Lilium.
[2] The corm tastes like elm-bark, and is eaten by children.

Erythronium Americanum, lambs' tongues, Banner Elk, N. C.
yellow bells, Shorthills, N. J.
yellow lily, Ferrisburgh, Vt.
Hemerocallis fulva, L., Eve's thread, West Va.
Hyacinthus orientalis, L., Jacob's ladder, No. Ohio.
Lilium Canadense, L., meadow lily, nodding lily, N. Y.
Lilium Philadelphicum, L., tiger-lily, N. J.
glade-lily, West Va.
Lilium superbum, L., nodding lilies, Mass.
wild tiger-lily, Minn.
Maianthemum Canadense, Desf., wild lily-of-the-valley, Penobscot Co., Me.
bead ruby,[1] N. Y.
Melanthium Virginicum, L., bunch-flower, West Va.
Oakesia sessilifolia, Watson, wild oats, Penobscot Co., Me.
straw-lilies, Conn.
Polygonatum biflorum, Ell., conquer-John, Mo.
Smilacina racemosa, Desf., Job's tears, N. Y.
golden seal, Banner Elk, N. C.
Smilax rotundifolia, L., biscuit-plant,[2] Cape Ann, Mass.
horse-brier, Mass.
Streptopus amplexifolius, D. C., } liver-berry,[3] St. Francis, Me.
Streptopus roseus, Michx., }
Trillium, sp., moose-flowers, N. Y.
Trillium erectum, L., daffy-down-dilly, orange-blossom, Bradford, Vt.
squaw-flower,[4] Ferrisburgh, Vt.
birth-root, nosebleed, N. Y.
Trillium erythrocarpum, Michx., Sarah,[5] Penobscot Co., Me.
Trillium grandiflorum (?) Salisb., bath-flower,[6] Franklin Centre, P. Q.
Veratrum, sp., branch eliber,[7] Banner Elk, N. C.
Veratrum viride, Ait., poke-root, Franconia, N. H.
Yucca aloifolia, L., Spanish daggers, Ala.
Yucca angustifolia, Pursh, soap-weed, Iowa.
Zygadenus elegans, Pursh, alkali-grass, Minn.

[1] Probably from the beauty of the berries.

[2] Children eat the tendrils and new leaves.

[3] From the supposed medicinal value of the cathartic fruit, which is freely eaten by children wherever the Streptopus grows.

[4] Perhaps from the smell.

[5] *Trillium erectum* is here called Benjamin, and children every spring go hunting Benjamins and Sarahs.

[6] Evidently a corruption of beth-flower, which is in its turn derived from birth flower, the Trilliums being quite generally known as birth-roots.

[7] Equivalent to branch hellebore, *i. e.*, the hellebore which grows along the brooks or "branches."

COMMELINACEÆ.

Tradescantia crassifolia (?) Cav., mother-of-thousands, Boston, Mass.
Tradescantia Virginica, L., spider lily, N. Y., New Orleans, La.

JUNCACEÆ.

Juncus, sp., sour-grass, Neb.
Juncus tenuis, Willd., poverty-grass, West Va.
wire-grass, Jones Co., Iowa.

ARACEÆ.

Acorus Calamus, L., calmus, N. J.
Arisæma triphyllum, Torr., wake-robin, Ferrisburgh, Vt.

ALISMACEÆ.

Sagittaria variabilis, Engelm., arrow-leaf, N. Y.

NAIADACEÆ.

Zostera marina, L., tiresome weed,[1] Little Egg Harbor, N. J.

CYPERACEÆ.

Carex, sp., nigger-wool,[2] Neb.
Cladium effusum, Torr., saw-grass, Fla., and other Southern States.
Cyperus strigosus, L., nut-grass,[3] Concord, Mass.
Eleocharis tenuis, Schultes, poverty-grass, kill-cow, West Va.
Scirpus lacustris, L., tule, Cal.
black rush, Minn.

GRAMINEÆ.[4]

Agropyrum glaucum, R. & S., slough-grass, pond-grass, Colorado blue-grass, blue-grass, S. W. Neb.
wheat-grass, Central Neb.
Agropyrum repens, Beauv., witch-grass,[5] Penobscot Co., Me.
Andropogon furcatus, Muhl., blue joint,[6] Minn.
Andropogon Hallii, Hackel, turkey-foot, W. Neb.
Andropogon scoparius, Michx., big blue stem, big blue joint,[7] Central Neb.

[1] From the obstruction which it offers to the oars of boats.
[2] From the blackish color of the leaves at the base.
[3] The tubers are eaten by children.
[4] For the names of most of the grasses given in this article, as well as for many notes upon them, the author is indebted to the kindness of Prof. C. E. Bessey.
[5] Never there known by any other name.
[6] In Maine *Calamagrostis Canadensis*, Beauv., is blue joint.
[7] In the western part of the plains this is one of the "bunch-grasses," and is often so-called.

Andropogon scoparius, broom-sedge, West Va.
Andropogon sorghum, Brat., Johnson-grass, So. Neb.
Aristida purpurea, Nutt., muskit grass, Tex.
Bouteloua hirsuta, Lag., black grama grass, Neb.[1]
Bouteloua oligostachya, Torr., blue grama grass, Neb.[1]
Bouteloua racemosa, L., tall grama grass, Neb.[1]
Bromus ciliatus, L., swamp chess, Neb.
Bromus ciliatus, var. *purgans*, Gray, swamp chess, N. W. Neb.
Bromus Kalmii, Gray, wild chess, Cent. and N. W. Neb.
Bromus Kalmii, var. *Porteri*, wild chess, N. W. Neb.
Bromus secalinus, L., chess or cheat, E., Central and N. Neb.
Buchloe dactyloides, Engelm., buffalo-grass, W. Neb.
Calamagrostis longifolia, Hook., sand-grass, Central Neb.
Cenchrus tribuloides, L., hedgehog-grass, West Va.
hedgehog-grass or bear-grass, Iowa.
Danthonia spicata, Beauv., June-grass,[2] Penobscot Co., Me.
Distichlis spicata, Greene, var. *stricta*, Thurber, salt-grass, N. W. Neb.
Eatonia obtusata, Gray, prairie-grass, Central Neb.
Eleusine Indica, Gærtn., dog's tail-grass, wire-grass, West Va.
Elymus arenarius, L., rancenria grass, Cal.
Eragrostis major, Host., stink-grass, Neb.
candy-grass, Central Neb.
Eragrostis tenuis, Gray, blow-out-grass,[3] Central Neb.
Festuca scabrella, Torr., bunch-grass, Cal.
Glyceria Canadensis, Trin., pearl-grass,[4] Waverley, Mass.
Holcus lanatus, L., old white top, feather-grass, velvet-grass, West Va.
Hordeum jubatum, L., squirrel-tail-grass, Neb.
Kœleria cristata, Pers., June grass, N. W. Neb., Central Neb.
Lolium perenne, L., English blue-grass, West Va.
Lolium temulentum, L., cheat, Berkeley, Cal.
Munroa squarrosa, Torr., false buffalo-grass,[5] Central Neb.
Panicum capillare, L., tickle-grass, West Va., Neb.
Panicum clandestinum, L., deer-tongue-grass, West Va.
Panicum sanguinale, L., pigeon-grass, Hopkinton, Iowa.
Panicum virgatum, L., switch-grass, wild red-top, E. Neb.
Paspalum undulatum, Poir., bull-grass, Ala.

Cambridge, Mass.

H. J. Webber.

[1] In Nebraska the three species above given are often confounded. The word *grama* or *gramma* means grass, but in spite of tautology the word grass is usually added. By many farmers *B. oligostachya* and *B. hirsuta* are called buffalo-grass.

[2] Farmers call the dead grass in the spring, "old fog."

[3] A "blow-out" is a crater-like cavity in the side of a sand-hill.

[4] Name given by a few children, some years ago.

[5] So called because it looks like buffalo-grass, but is worthless.

The nature and distribution of attraction-spheres and centrosomes in vegetable cells.[1]

JOHN H. SCHAFFNER.

WITH PLATE XXXIII.

Introduction.

The question as to the nature of centrosomes and attraction-spheres and their importance in the cell is still in dispute. Some hold that these bodies are only temporary accumulations of the cytoplasm of the cell, while others contend that they are permanent organs, which are secondary in importance only to the nucleus itself. Moreover, the number of these bodies in each cell, their movements and manner of division, their action during impregnation of the ovum, whether they remain on the outside or inside of the resting nucleus, and even their action during the process of indirect cell division are all questions more or less in dispute. It seems, however, that from the chaos of opinions enough truth can be discovered to enable one to arrive at a safe conclusion in regard to many questions relating to them. Since the work hitherto done on plants was more especially in connection with reproductive cells, it was my purpose to work entirely with purely vegetative cells,—to study the existence of centrosomes and attraction-spheres in these cells, to find whether they remain on the outside of the resting nucleus or are included by the nuclear membrane, to determine the number of these bodies in each cell, and to trace them from the resting nucleus through the stages of karyokinesis. In my investigations, I had the assistance of Professor F. C. Newcombe, to whose suggestions are largely due whatever success I may have attained.

Historical.

Discovery.—To Professor E. van Beneden (26)[1] belongs the honor of having discovered the attraction-sphere. In the year 1887, he found in the fertilized ovum and the blastomeres of Ascaris megalocephala, at the poles of the nuclear spindle,

[1]Contribution from the Botanical Laboratory of the University of Michigan.
[1]The numbers refer to the bibliography at the close of the paper.

definite spheres each with a dense center, which he considered as permanent cell organs in connection with the nucleus. In the following year Boveri (1) observed the sphere and its center. He called the dense central body the centrosome, and regarded it as a contribution from the spermatozoon to the attraction-sphere of the ovum.

Distribution.—Investigations were made on various kinds of sexual cells until the year 1891, when Flemming (5) first found the attraction-spheres and centrosomes in the resting stages of leucocytes and in the epithelial cells of the lungs of the salamander. In the same year Guignard (10) demonstrated the existence of these bodies in reproductive vegetable cells, both in the resting stage and during karyokinesis. Since that time they have been found in the cells of many kinds of tissues, and especially in the ova of various animals.

Heidenhain (14) found them in the leucocytes of the salamander, in the medullary cells of the bones of young rabbits, and in the alveolar epithelium and leucocytes of the lung of a pneumonic patient; Bürger (3), in the proboscis-sheath of nemerteans, in resting cells; van der Stricht, (29) in the blastomeres of Triton and in the cartilaginous cells of several amphibia; E. de Wildeman (32), in Spirogyra and in the spore-mother-cells of Equisetum; Bütschli (4), in Surirella; and Schottländer (25), in the antheridia of Gymnogramme and in the spermatozoids and the ova of Chara. Heidenhain (15½) in a recent investigation has made a special study of centrosomes in the lymph cells (lymphocytes) and giant cells (megacaryocytes) from the bone marrow of the rabbit. He found them also in the spleen of the rabbit, and in the lymphatic gland and the wall of the intestine of the dog. Thus the bodies have been demonstrated in reproductive cells of both plants and animals, and also in non-reproductive animal cells.

General description.—The general appearance of a centrosome and its surrounding attraction-sphere is described by van Beneden (28) as a dense "cytocenter" around which may be distinguished a medullary and a cortical zone concentric to the central corpuscle. Heidenhain (15) also lays emphasis on the fact that the attraction-sphere is sharply limited from the surrounding protoplasm, and in many cases shows a distinct radiate structure. Guignard (10) says, in regard to the bodies seen by him in plant cells, that the attraction-spheres were composed of transparent granular areas in which the centrosomes lay. Attraction-spheres and centrosomes vary in size in different kinds of cells. Flemming found them very small in the epithelial cells of the salamander's lungs, while in leucocytes they were much larger. Bütschli (4) says that the centrosomes, observed by him in Surirella, were so large that they were visible as a dark round granule even in the living cell.

There was a divergence of opinion, almost from the beginning, as to the number of these bodies in each cell. Many observers claimed that there was but one in the resting cell, and that this one divided before the nucleus began to divide; while others held that there were two to each resting nucleus, and that each of the two divided during nuclear division, so that each daughter nucleus was again provided with two. Flemming (5), in 1891, found the bodies double much more often than single, and he thought that where only one was seen the other might be hidden. Heidenhain (15), in 1892, stated that the number of centrosomes with each resting nucleus is always two. Guignard (10) also found them always double. Bürger, van Beneden, and van der Stricht evidently hold the opinion that there is only one. Thus there is room for doubt as to whether there may not be variation, in some tissues but one and in some two for each resting cell.

But Heidenhain (15½), in 1894, found in many cases along with the two centrosomes a third body, and sometimes a fourth, which he regards as an accessory centrosome (Nebenkörperchen). That is, he thinks that the accessory centrosome is nothing else than a centrosome of the smallest kind, which has its origin from one of the larger centrosomes. In the giant cells from the bone-marrow of the rabbit he found large numbers of centrosomes grouped together, sometimes as many as 135 in a group. There is generally one main group of these bodies in each cell, with one or more smaller accessory groups.

The bodies have been found quite universally in the same positions as regards the nucleus. In the resting cell they generally lie in a depression of the nucleus, close together, while during mitosis they are at the poles of the spindle. But Hansemann (12), while he holds that the centrosomes are permanent organs, believes with O. Hertwig (13) that they are in the nucleus during its resting stage and only come out in the first stages of division.

Activity and function.—According to Guignard (10), at the beginning of nuclear division spheres migrate to the poles of the future nuclear spindle and then each one divides during the prophase of nuclear division. But according to those who hold that there is only one attraction-sphere to the resting nucleus, the division takes place before the migration. Van der Stricht (29) finds that the division in the egg of Triton is, as a rule, effected in the quiescent stage of the nucleus, rarely during the anaphase, and exceptionally during the metaphase.

According to Heidenhain ($15\frac{1}{2}$) every centrosome arises from another one, not by self-division, but by budding, the largest centrosome in a group being the oldest, and the smallest the youngest.

The origin of the attraction-sphere and centrosome in the fertilized ovum does not seem as yet clearly worked out. As already stated, in the year 1888 Boveri advanced the opinion that the centrosome was brought into the attraction-sphere of the ovum along with the spermatozoon. But Guignard (10) found in the cells of the embryo-sac of Lilium Martagon that the attraction-sphere contained a centrosome before fertilization; so the hypothesis of Boveri must be given up. According to Guignard (11) there is a union of the attraction-spheres and their contained centrosomes accompanying the conjugating nucleus of the pollen-tube, with those of the nucleus of the embryo-sac during fertilization. He says that in angiosperms the two spheres brought with the male nucleus unite with the two of the female during the fusion of the two nuclei, leaving the new nucleus with two spheres, each composed of a male centrosome and its sphere united with similar bodies from the female.

Immediately, when van Beneden had made the discovery of attraction-spheres, he advanced an hypothesis as to their nature and distribution. According to van Beneden's hypothesis, there is in the cell outside of the nucleus a permanent cell organ—the attraction-sphere with its centrosome. This organ propagates itself by division when the cell does, but the division of the sphere precedes that of the cell. The rays of the spindle are attached to the sphere and are contractile fibers which attach themselves to the chromosomes and draw their halves towards the poles. The contractile rays of the spindle obtain a firm hold, for the spheres are held in place by the cytoplasmic threads of the polar radiations. Thus an important part of the karyokinetic process would take place outside of the nucleus. Van Beneden also made the generalization that the spheres with their central bodies were of quite general distribution in both animal and vegetable cells.

Heidenhain (15½) considers that the attraction-sphere is not a constant characteristic of the cell but, as is the case in leucocytes, it is present only during the resting period of the cell, and not during the process of karyokinesis; thus the attraction-sphere is not considered to be an organ in the exact meaning of the word. He considers that the "microcentrum" (centrosome with its envelopes) of the higher organisms corresponds to the paranucleus of the protozoa while the nucleus corresponds to the macronucleus. He gives some important discussions on the physiological rôle of centrosomes and the law of their position, together with other theoretical views, but since they are beyond the scope of this paper they will not be considered here.

Bürger's (2) views are the following: He thinks that the bodies are not permanent organs, but that they are simply due to certain mechanical processes; that the central body is not the cause but the result of polar attraction. That is, he thinks the microsomes are attracted toward the center of the polar region from the periphery, and since they are solid bodies, if they are attracted equally from all sides, they form a hollow sphere which is the attraction-sphere.

Watase (31) has advanced an hypothesis somewhat similar. He thinks that the centrosome is simply a large microsome formed at the point where the greatest number of cytoplasmic filaments meet; that a barrel-shaped spindle possesses several independent microsomes at each pole instead of one centrosome. But this explanation, as well as that of Bürger, corresponds to so few of the observed facts that it seems entirely improbable. It surely could not be a reasonable explanation of the two bodies seen beside the resting nucleus by Guignard and others, nor the four spherical bodies, which can be so easily seen during metakinesis in cells of the ovary of Lilium and other plants.

For the filamentary structure of cytoplasm has not yet been demonstrated in plants; and if the centrosomes are only large microsomes, then the spindle must be divided into halves to produce the two centers at the poles, or else there must be a crossing of filaments below the two centrosomes, neither of which has been observed.

If the views of those who hold van Beneden's hypothesis are correct, it becomes evident that every centrosome with its attraction-sphere must arise from a previous one, all the centrosomes in an organism arising from the primary one in the ovum, or according to the view of Guignard, from the two that are in the fertilized ovum, each of which represents the union of a male centrosome with one from the female. And thus they can be traced backward or forward from one generation to another the same as the nucleus.

The question naturally arises as to whether these bodies are present in cells which divide by amitosis, and if present what their action is during the process. Flemming (8) states that in leucocytes, where division is both direct and indirect, the "central bodies" are present; but they do not seem to be implicated in the fragmentation or direct division of the nucleus. He does not state what becomes of the spheres when fragmentation takes place, but concludes that only the products of karyokinetic division continue to live and multiply. Neves (19) has worked upon this subject with the spermatogonia of the salamander. He reports some discoveries, which, if they can be substantiated, truly present some very wonderful phenomena. He says that he saw the attraction-sphere become oblong, and that in various stages of the constriction of the nucleus the elongated attraction-sphere was twined in a ring about the constriction. In some cases the two ends of the elongated body appeared as though they were not yet fused together. When the division was complete, the elongated body appeared like a ring lying between but to one side of the two daughter nuclei; but there was only one of these bodies to the two nuclei. No further observations were made in regard to the subsequent action of the body and the two daughter nuclei; so the question of attraction-spheres in relation to amitotic division is yet in a very unsatisfactory state.

Plant cells especially.—The work hitherto done with plants is as follows: Guignard's investigations stand as one of the most important contributions to the subject. Guignard (10) found the attraction-spheres and centrosomes both in resting and dividing pollen-mother-cells of Lilium, Fritillaria, Listera, and Najas; in the mother-cells of the embryo-sac, with nuclei both at rest and in stages of division; in the cells of the female apparatus derived from this nucleus; and in the endosperm. He found them in the microsporangium of Isoetes, and in the sporangium of Polypodium and of Asplenium. In his more extensive report (11) he adds many new and interesting facts, giving numerous illustrations of the appearance of these bodies in Lilium Martagon, Listera ovata, Lecojum vernum, and Galanthus nivalis. Bütschli found very large centrosomes in Surirella, a large form of diatom. E. de Wildeman (32) has found the attraction-spheres and centrosomes in Spirogyra jugalis and nitida, and in the spore-mother-cells of Equisetum, both in resting and division stages of the nucleus. Schottländer (25) claims to have found centrosomes in the male sexual cells of Marchantia polymorpha, but no attraction-spheres surrounding them. He found the attraction-spheres in the antheridia of Gymnogramme chrysophylla, and in the spermatozoids and the ova of Chara foetida. Thus in the reproductive cells of plants, and those directly concerned, the presence of attraction-spheres and centrosomes has been quite generally demonstrated, but has been reported in vegetative cells in but two cases.

Investigation.

The present work on centrosomes and attraction-spheres was begun in November, 1893. The growing tips of roots were principally used, though investigations were also made on other plant tissues. All of my material which needed sectioning was prepared according to the ordinary methods, by imbedding in paraffin and afterwards staining the sections on the slide; though I also did some staining *in toto*. After quite extensive experimenting, several methods were found of advantage in studying these bodies. Hermann's method, as given in Dr. A. Zimmermann's "Die botanische Mikrotechnik" 1892, was used very successfully on the root tips of *Allium cepa* L. The centrosomes are stained very black while the attraction-sphere is often quite clear, though sometimes somewhat stained by the safranin. The dark granular limiting layer is well defined, while the surrounding cytoplasm is red. The method is as follows: Fix the objects for one or two days in a solution of fifteen parts one per cent. platinum chloride, one part acetic acid, two to four parts two per cent. osmic acid, eighty parts water. Now wash the objects in flowing water, harden gradually in alcohol, and after that place them from twelve to eighteen hours in pyroligneous acid. Next place the objects in a solution made of one part twenty per cent. hæmatoxylin, ninety-nine parts seventy per cent. alcohol. Keep in the dark and leave from twelve to eighteen hours, and after that in the dark for some time in seventy per cent. alcohol. Imbed and section. After the sections are fastened to the slide, cover them with a solution of potassium permanganate, which has so much water that it possesses a light rose color, and leave until they have an ocher color. Then wash the sections with a solution of one part hydric oxalate, one part potassic sulphate, 1,000–2,000 parts water. After this, stain the sections for three to five minutes in a saturated alcoholic (100%) solution of safranin; clear and mount in Canada balsam. I also prepared root tips in Flemming's fixing fluid, and after imbedding and sectioning, stained first with Kleinenberg's hæmatoxylin and then with a two per cent. aqueous solution of acid fuchsin. The ovaries and anthers of *Lilium longiflorum* Thunb., I stained in several ways. The centrosomes and attraction-sphere will be stained quite well, however, by simply leaving them for a considerable length of time in anilin-safranin, and then taking out the excess of color with alcohol. By another method I took equal parts of an aqueous (two per cent.) solution of acid fuchsin and acetic methyl-green, which in some cases made a very favorable stain.

The last method tried was one suggested to me by Professor Newcombe: (1) a one per cent. aqueous solution of ferrous sulphate, (2) a five per cent. aqueous solution of tannic acid, (3) anilin-safranin (one part of one per cent. alcoholic solution of safranin with two parts water), (4) an aqueous solution of picro-nigrosin, strong enough to have a dark bluish-green color. The slides holding the sections were placed thirty to forty-five minutes in the iron solution, then washed in water; next, the same length of time in the tannin, and washed again. Now the sections were covered again with the iron solution and left for a minute or two or until they changed to a rather dark color. After washing off the iron in a stream of water they were stained in the anilin-safranin from thirty minutes to one hour, and afterwards fifteen minutes or more in the picro-nigrosin. After raising them through the grades of alcohol and being careful so as not to take out too much of the safranin stain, they were mounted in balsam. The centrosomes were stained very dark and the attraction-spheres well defined, often showing the radiate structure. Any of the above methods will give fairly good results with plant cells, if proper care is taken; but I prefer Hermann's method or the iron-tannin-safranin stain as giving the best results.

I found the bodies as a rule very small and used continually a Zeiss $\frac{1}{12}$ immersion lens, and generally a no. 8 compensating ocular. As a general rule, I think more difficulties are encountered in studying these bodies in plants than in animals. The killing fluids do not penetrate so readily, which causes more displacement and distortion of the elements of the cell. In the vegetable cell, moreover, are generally present large numbers of chromatophores, starch grains, crystalloids, and other such bodies, which may greatly interfere with the identification of such small bodies as centrosomes. In the root tips which I studied, I found the leucoplasts a constant source of trouble; and many stains which might otherwise be very useful become worthless because of the readiness with which they color these bodies. The radiate structure of the cytoplasm is also much less marked than in animal cells.

I found centrosomes and attraction-spheres in the following named material: in the young root tips of *Allium cepa* L. (figs. 1–11), in resting cells and the various stages of karyokinesis; in the root tips of *Vicia faba* L. (fig. 15); in the root tips of *Tradescantia rosea* L. (fig. 16); in the resting cells of the epidermis of the old bulb scales of *Allium cepa* L. (figs. 17 and 18); and in the epidermis of the anther (fig. 14) and the walls of the ovary of *Lilium longiflorum* Thunb. (figs. 12 and 13).

In the onion root tips, I was able to trace them through nearly all the stages of nuclear division (figs. 1–10) as well as in the young ovaries of Lilium. In the other material I did not trace them through the whole series, but in the Vicia and Tradescantia root tips I was able to see them in several of the stages of karyokinesis. In the epidermal cells of the lily anther, I found them quite common in cells that were completely in the resting stage (fig. 14); while in the epidermis of the onion scales, where all the nuclei were in the resting stage and where there is no subsequent cell-division, I also succeeded in demonstrating the existence of these bodies in many cases (figs. 17 and 18).

Whenever I observed the bodies in resting cells, there were always two centrosomes, each with an attraction-sphere, which was in most cases marked off from the surrounding cytoplasm by a well defined granular layer; and in cases where karyokinesis had advanced to any considerable extent, two centrosomes could be distinguished at each pole of the spindle. Sometimes there appeared to be but one at each pole, but careful focusing generally demonstrated the fact that one was lying below the other. In the root tips of Allium, where the division is tranverse to the axis of the root when one goes a little distance from the apex, the attraction-spheres always appear at the upper or lower end of the nucleus as seen in longitudinal section. In the resting cells, they generally lie quite close to the nucleus in a little indentation.

In the epidermis of the onion scales I observed these bodies in a sufficient number of cases to convince me that they were true attraction-spheres, since they had the same appearance and took the same stain as those which I saw by the side of the close skein of the daughter nucleus. Now in these epidermal cells of the onion scales the nuclei are all resting, and therefore the objection that the centrosomes may have just come out of the nucleus in the beginning of division cannot be made; and so I hold that the attraction-spheres with their centrosomes do not enter the nucleus during its resting stage but remain permanently outside of the nuclear membrane. Moreover, these cells of the epidermis of the bulb scales of Allium were all definitive resting cells; yet with the iron-tannin-safranin stain it was demonstrated that the centrosomes and attraction-spheres were still present beside the nucleus, and that they retained their usual structure.

When division of the nucleus takes place, I found the attraction-spheres in the onion roots at the very beginning of the close mother skein stage, one at the upper and one at the lower pole of the future spindle, still close to or in contact with the nucleus (fig. 2); and though I did not find any stage where one of the bodies had gone only part of the way around, yet there can be no doubt that one or both had traveled around from their original position to the poles. In the following stages the spheres elongate, and generally by the time when the nucleus has reached the loose mother skein (fig. 3) the centrosomes and their spheres have divided, though they still lie closer together than in the later stages. During metakinesis and the daughter star stage (figs. 5-7), they can be seen very distinctly at each pole; and they keep this position in relation with the nucleus through all the succeeding stages of the division (figs. 8–10), and through the resting stage of the nucleus until a new division of the nucleus takes place.

It will be seen from the fact that the centrosomes remain at the position of the pole of the daughter nucleus until the division following, that in the case where the next spindle is in the same direction as the preceding one, one of the centrosomes must travel through 180° to come to the opposite pole of the nucleus. But in the case where the division is at right angles to the preceding one, each centrosome must travel through 45° in order to reach the poles of the future spindle. Now in the Allium root tips, in many cases, in a given chain of cells, division will take place logitudinally at a certain distance from the apex; and from that point onward there will be two chains of cells instead of one, and farther on the division of the nucleus will again be in a plane transverse to the axis of the root. Thus taking such an example where the cell has divided transversely, if the next division is longitudinal each centrosome must pass through 45°; the next division being transverse again both bodies must again travel as before; but in the third division one of the bodies will be stationary while the other passes through 180°. In a strand of cells coming from the apex of the root, the cells as they continue to divide always maintain a curve, and the attraction-spheres will not be quite 180° apart as they lie at the two poles of a dividing nucleus. I have observed in cells at these points, that the spheres lay inclined with the daughter nucleus toward the concave side of the strand of cells. The bodies do not always travel in the same direction, as will readily be seen when we take into consideration a strand of cells from an onion root whose elements are dividing transversely. If the spheres are at the proximal end of the nucleus when division occurs, the migrating one will travel in a direction toward the apex of the root; but if they lie at the distal side of the nucleus it must travel in the opposite direction. The whole subject shows that the centrosomes with their spheres travel in a very complicated manner during the formation of any given vegetable tissue.

A very peculiar phenomenon was noticed in the root tips of Allium. In many cases the spindle was formed obliquely in the cell, the attraction spheres lying near opposite corners of the cell as it appeared in longitudinal section (fig. 11).

The actual length of the spindle from pole to pole was greater than the length of the cell. It appeared as though there was not enough room for the division of the nucleus, and the bodies had wandered to the corners in order to gain more space for the formation of the spindle. It seems to me that this phenomenon explains itself if we admit that the attraction-spheres are directive in their function, and control nuclear division; but the appearance might be just as well accounted for by supposing that the controlling power rested in the nucleus or the cytoplasm of the cell in general.

Results.

The special results of the investigation are as follows:

1. Centrosomes aud attraction-spheres are present in non-reproductive as well as reproductive vegetable cells.

2. They remain on the outside of the nucleus during its resting stage.

3. They persist in cells which have ended their growth and division.

Besides the foregoing results, the present investigation furnishes confirmation to the following propositions:

1. In phanerogams there are two of these bodies for each resting nucleus.

2. When the nucleus begins to divide, one or both of the bodies migrate so as to take their positions at the poles of the future spindle.

3. Subsequently they immediately begin to divide, the division being completed in the prophase of the mother nucleus.

4. After their migration, the attraction-spheres remain at the poles of the nuclear spindle, and do not change their position until the beginning of the following division.

5. They seem to be organs which institute and direct nuclear division.

Summary.

The theory advanced by Van Beneden has received the support of many of the leading biologists, and has with some additions been quite generally substantiated by investigations. Taking the facts and opinions of those who have studied these bodies, into general consideration, the subject seems to be in the following condition: There is a permanent body in the cell—the attraction-sphere with a centrosome—which is of universal distribution in both plants and animals—at least in all cells which divide by karyokinesis. This body propagates itself by division. As a rule, there seem to be two of these bodies for each resting nucleus, but in some cases only one. They remain constantly ouside of the nucleus. They appear to be the organs which direct nuclear division. It seems that there is a union of the attraction-spheres and centrosomes accompanying the male nucleus with those of the female nucleus during impregnation of the ovum. The bodies migrate and divide, and are thus carried from one cell to the other throughout the entire organism, whether plant or animal.

Ann Arbor, Mich., June, 1894.

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Explanation of Plate XXXIII.

Figs. 1-11, *Allium cepa*—root tips.

Fig. 1. Resting nucleus, showing two attraction-spheres with controsomes.—Fig. 2. Beginning stage of division, one attraction-sphere being at e ch pole. The centrosomes are slightly elongated.—Fig. 3. Loose mother skein; the attraction-spheres have completely divided —Fig. 4. Formation of the nuclear spindle; the attraction-spheres and centrosomes lie at the poles.—Fig. 5. Metakinesis; the bodies were seen only at one end of the spindle.—Fig. 6. Metakinesis farther advanced; the attraction-spheres with their centrosomes appear at each pole of the spindle, and are surrounded by the cytoplasmic radiations.—Fig. 7. Daughter star; at the upper end of the spindle one of the centrosomes is displaced.—Fig. 8. Loose daughter skein, showing the four attraction-spheres.—Fig. 9. Close daughter skein, only the upper nucleus showing the bodies.—Fig. 10. Daughter nucleus nearly complete. The nuclear membrane

has appeared. The two centrosomes with their spheres appear at the upper side.—Fig. 11. A cell in which the spindle lies obliquely.

Figs. 12–14, *Lilium longiflorum.*

Fig. 12. Last stage of metakinesis, showing the attraction-spheres and centrosomes, with cytoplasmic radiations around the poles. (From wall of young ovary.)—Fig. 13. Last stage of close daughter skein; the upper daughter nucleus shows attraction-spheres and centrosomes. (From wall of ovary.)—Fig. 14. Resting nucleus from the epidermis of the anther, with two attraction-spheres.

Fig. 15. *Vicia faba*—root tips. Daughter star; showing two centrosomes with attraction-spheres at the upper end of the spindle.

Fig. 16. *Tradescantia rosea*—root tips. Close daughter skein; the centrosomes with spheres appear at the lower side.

Fig. 17. *Allium cepa*—epidermis of bulb scales. Resting nucleus with two attraction-spheres and centrosomes.—Fig. 18, similar to fig. 17.

Notes on dédoublement.

AUG. F. FOERSTE.

Trillium sessile. Three interesting cases of more or less quaternate structure in this species of Trillium have recently come under our observation. One of these is quite simple in character. First came a pair of opposite broader leaves, followed in decussating order by a pair of narrower leaves, an outer pair of sepals, an inner pair of sepals, then by a set of four petals decussating with the two sets of sepals taken as a whole, next by four outer stamens, these by four inner stamens, but of practically similar insertion, and lastly by an ovary which bore four distinct styles.

Mr. Ed. Rynærson, teacher of botany at the Dayton High School, found a vastly more interesting case which he placed at the writer's disposal. To appreciate this fully it must be remembered that the sepals of this species are green and the principal veins are longitudinal and parallel, while the petals are dull purple brown in color and have veins which incline towards either side of the petals and show more or less of an anastomosing structure. First there is a pair of opposite leaves (fig. 1), next a pair of slightly narrower leaves. With these four leaves as a whole, the sepals if there be four acting together as a whorl should decussate. And with these four sepals four petals should decussate. To determine how a plant with only six floral envelopes could manifest this tendency might puzzle a mathematician, but the question has been solved by this curious plant in a very odd manner.

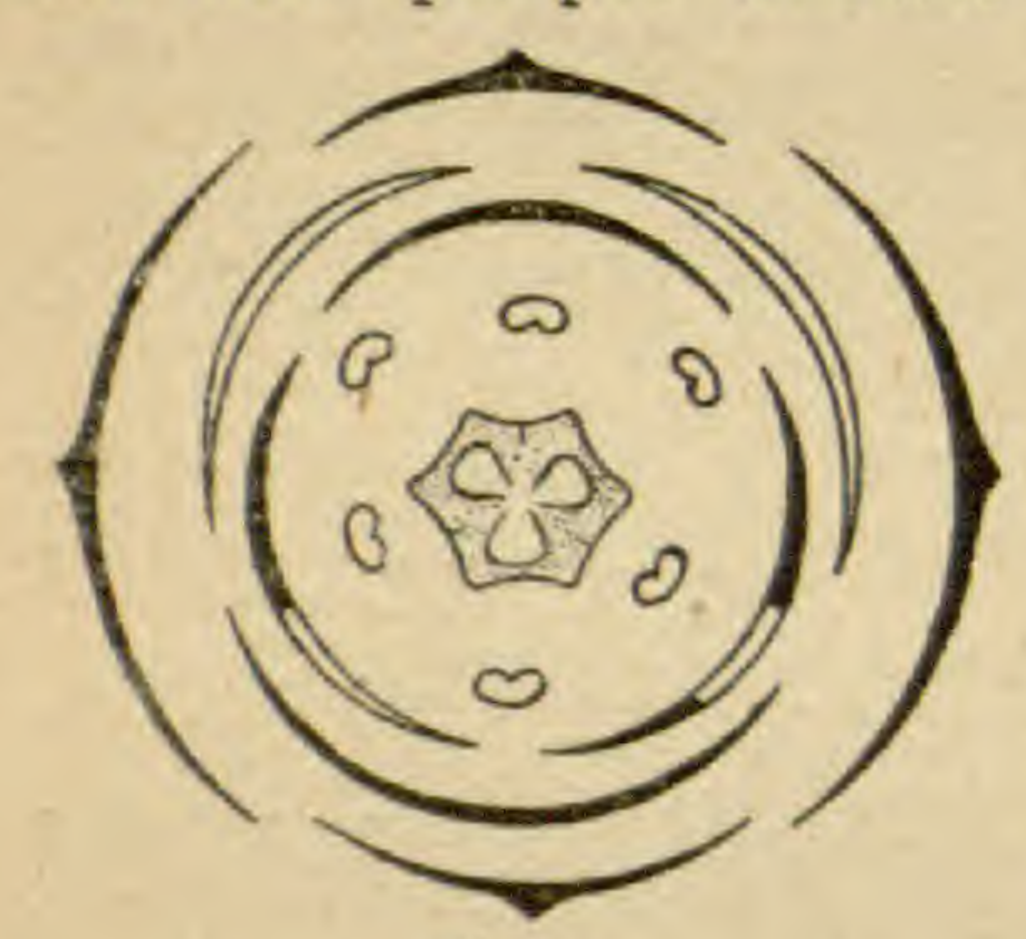

Fig. 1.

On either side of one of the second pair of leaves is found a sepal in decussating position. On either side of the opposite leaf is found a floral envelope in position a petal but in appearance partly petal and partly sepal. One of these is colored and veined like a petal on the outer half, and colored and veined like a sepel on the inner half, so that this inner half falls in the proper space to represent a third sepal. The other floral envelope is colored and veined like a petal on the outer half; the strip along the inner half of the petal for about a quarter of the width of the floral leaf is green and parallel veined like a sepal, but the quarter strip on the inner edge of this floral leaf is again colored and veined like a petal. The result is that these two floral envelopes, petals in position on a ternate arrangement, show sepal character along their inner halves, where the other pair of sepals should be on a quaternate plan.

To complete the analogy that third floral envelope on a ternate plan which should be a sepal, shows all the characters, both in color and venation, of a petal. Opposite to this between the two undoubted sepals is found the regular petal. On either side, to complete the quaternate whorl, would then come those halves of the peculiar floral envelopes described above, which are colored and veined like petals. The purple color and anastomosing veins on the other side of the purple strip can not destroy this analogy, but only add to the interest of the case. The tendency towards quaternate structure induced by the four leaves is therefore shown by the coloring and venation of the floral envelopes, while the return to the ordinary ternate structure is heralded by the actual number of floral envelopes (6) produced. There are six stamens and three styles.

In a third case, also found by Mr. Ed. Rynærson are found two leaves (fig. 2), followed by two other leaves; decussating with these are four sepals; almost decussating with those at three places are three petals, heralding the return to the ternate type, and at the place where the fourth petal ought to be, two stamens are found, attached by their filaments below, of which that stamen which should according to the quaternate plan be the fourth petal has a somewhat broader filament. Not counting this half of the compound stamen, there would be six stamens, following the three petals in regular ternate order. Including that half of the stamen there would be seven stamens, but with that interpretation, if viewed only as an ordinary stamen, there would be no logical explanation of the sequence of the floral leaves, or of the presence of the seventh stamen. There are three styles.

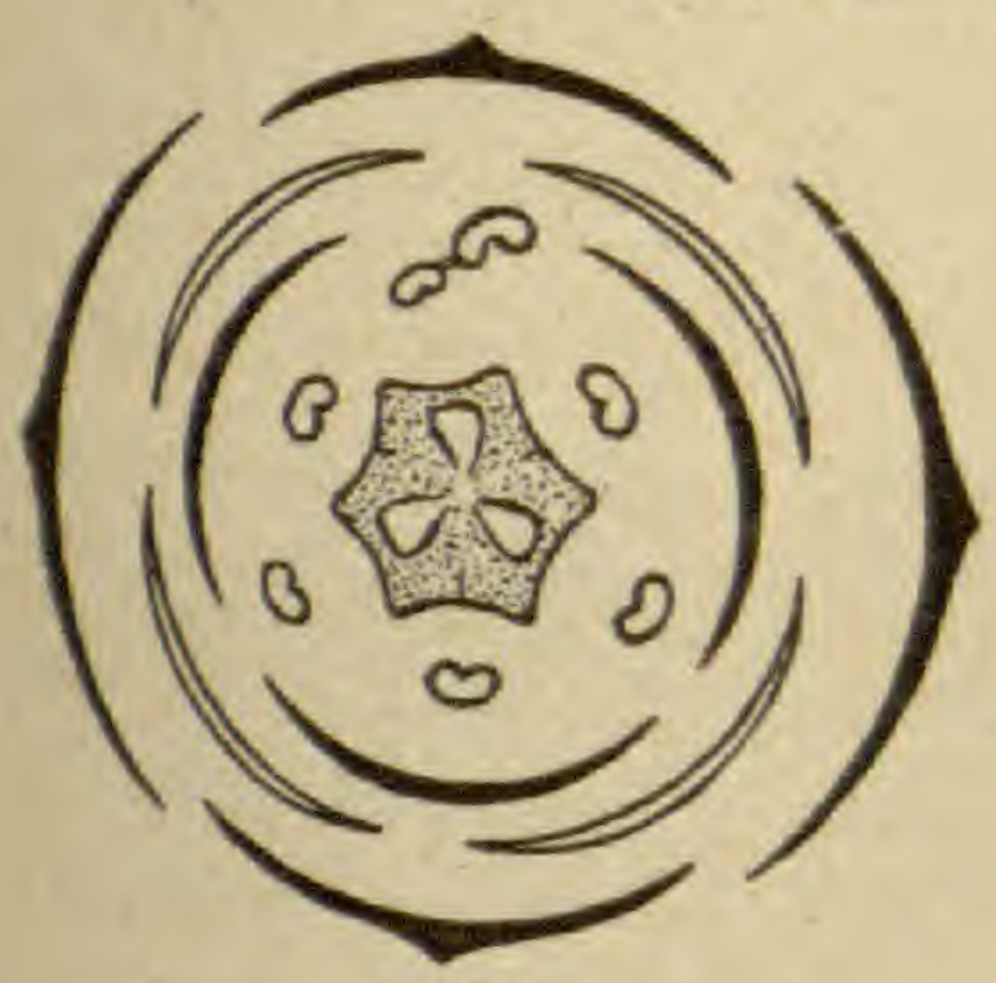

Fig. 2.

Nothing could be more interesting from the point of view of phyllotaxy than this attempt of plants to maintain a quaternate phyllotaxy, after numerically they had gone over to the normal ternate plan.

A fourth case, also found by Mr. Rynærson, has three ordinary leaves in ternate order (fig. 3). There are two ordinary sepals, and the third one has been replaced by a green leaf of about one-half the ordinary size, but divided almost to the very base, the venation of each half near the base being obliquely outward as when forming part of an entire leaf. The result is that the two divisions of the leaf-like sepal and the two ordinary sepals take up a position which is ternate to a certain extent and decussate with reference to the normal leaves, but more quaternate when considered among themselves. It is impossible to reproduce this effect satisfactorily in a diagram. Decussating with this set should come four petals if the quaternate plan is to be carried out. The fact is that the petals do decussate, but there being only three petals, this leaves one space vacant. Next on the quaternate plan there should be four stamens, one above each of the two normal sepals, and one above each division of the leaf like sepal. These are present. Next should be found four stamens, one over each of the petals present, and one over the space left vacant in the row of petals; but the last one does not occur, thus showing a return to the ternate order numerically but not necessarily in position. Finally, if the quaternate arrangement is to hold, one style should appear over each of the outer (four) stamens. These occur, but one of them is smaller and its cell is narrower than in the rest. The numerical order is therefore three, four, three, four, three, four, the quaternate *position*, however, being maintained, even where the actual number of parts had gone back to the ordinary arrangement in threes.

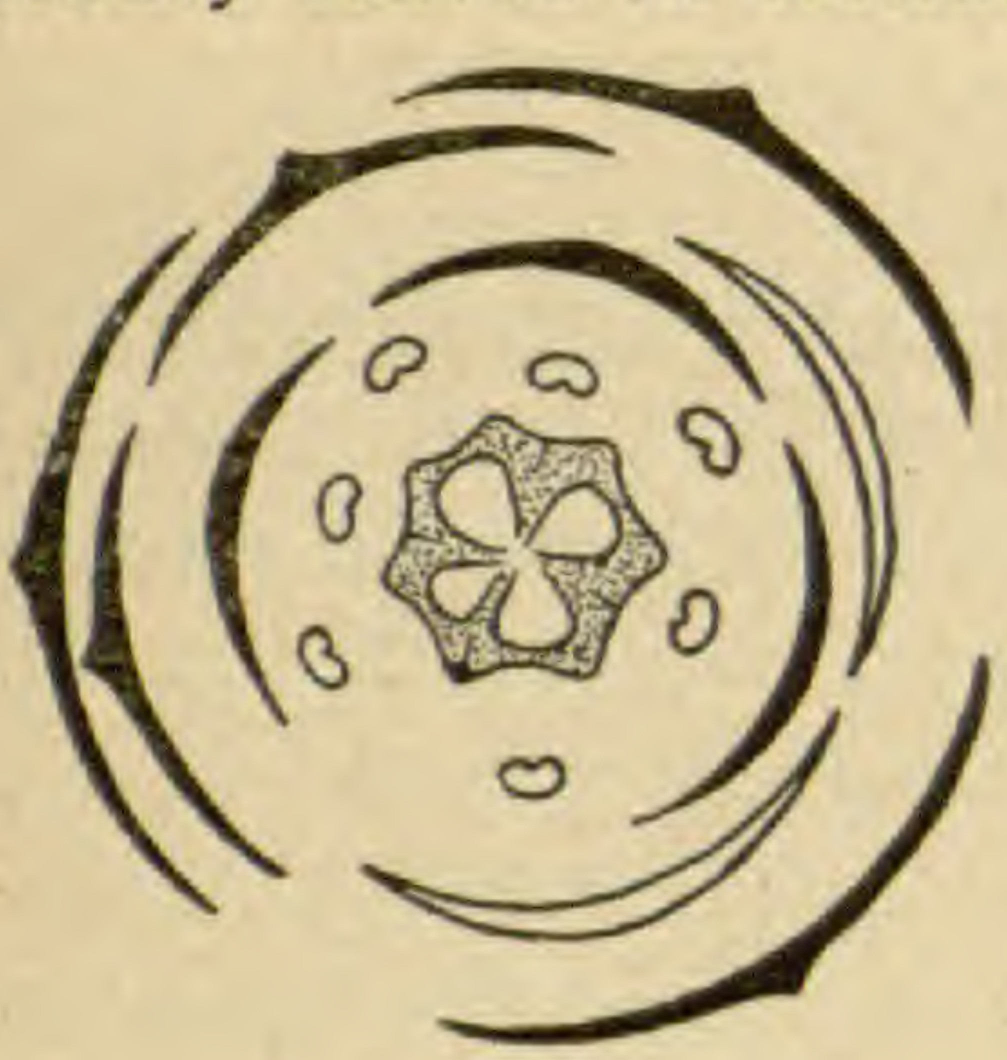

Fig. 3.

Ulmus. Mr. W. B. Werthner, teacher in the High School here and an expert botanist, found this spring on McDaniel St. a very interesting set of cases of dédoublement of leaves which seemed to be quite common in the young vigorous elms along the sidewalk. He very kindly placed this material at the disposal of the writer. The trees had recently been pruned, and the material in question consisted of the twigs which had fallen into the street. It being early spring, only the leaf-scars remained to indicate the fallen leaves, but the scaly leaf buds were well shown. We will use the term leaves instead of leaf-scars.

In the most interesting case the third node above the cut end of the twig showed a bud in the axil of the leaf, and a smaller one in the axil of the lower stipule. Two leaves, each subtending a bud, occur after intervals of six, four, seven, six, and again of six nodes, in the last case the pair appearing just beside the terminal scar. There is here a sort of tendency towards the recurrence of dédoublement after an interval of about six nodes.

On a second twig, one of the lowest nodes shows also a bud in the axil of a leaf and a second smaller bud in the axil of the lower stipule. At the fourth succeeding node the leaves are opposite and do not maintain the usual lateral position of the one half phyllotaxy, the pair having a diagonal position. Above this point every alternate leaf is separated by a shorter internode from the leaf below, so that the leaves have an evident tendency to form decussating pairs. First are found three pairs, of which the leaves are separated by shorter internodes, then one pair of which the leaves are opposite, next a pair of which the leaves are separated by shorter internodes, and finally at the tip of the stem, a pair of leaves which are opposite, and on each side of the terminal scar. The tendency to form decussating pairs is here very marked, and is fully successful at irregular intervals.

In a third case, two leaves, each subtending a bud, occur at the fifth node from the cut end, and also at the fourth succeeding node. Then two buds occur separated by shorter internodes, and next are found two leaves subtending a single bud placed in their conjoint axil. At the second axil above this two leaves each subtending a bud occur. Then come two buds separated by shorter intervals, and next two leaves, with two buds, of which one is larger. After this come five buds presenting a sort of two-fifths phyllotaxy.

On a fourth twig the second node bears two leaves subtending as a pair but a single bud. At the second node above are two leaves each subtending a bud; this recurs at the fifth succeeding node, and is followed by two leaves separated by a shorter internode, and then by two which are almost opposite, and these in turn by two leaves at the same node, each subtending a bud. The pairs of the whole series decussate after a fashion. At the third node above occur two leaves, as a pair subtending a single bud. At the second succeeding node are two leaves each with a bud, and then follow six or seven buds, as far as the tip of the twig.

On a fifth twig two leaves, as a pair subtending a single bud, are followed in the same vertical plane by two opposite leaves and buds, and these by a similar pair in decussating position. Next follow ten leaves in a sort of spiral phyllotaxy, the alternate leaves being separated by shorter and shorter internodes on going higher up on the twig, so that the ninth and tenth leaves are again almost opposite. Then the phyllotaxy becomes spiral again. A branch growing from this twig shows at one node a bud in the axil of a leaf and a second bud in the axil of a stipule.

As a series these twigs show a tendency to recurrence of the abnormal phyllotaxy even after a more or less successful return to normal conditions. The presence of two leaves (or rather leaf-scars) subtending a single bud, and occasionally of a bud also in the axil of a stipule, is especially interesting.

Arisæma triphyllum. Marion Nichols, one of the pupils of the High School, brought in a remarkable case of dédoublement in the Indian turnip. Two leaves have developed on the same petiole. The petioles coalesce perfectly below, but show an impressed line in front and in the rear towards the top. The middle leaflet of each leaf is of course distinct; so are also the two inner leaflets of each leaf. On the contrary, the two outer leaflets, which one might expect to be farthest removed, have grown together along their midribs, but are free elsewhere. In the axil of this double leaf is a double flowering stem also coalesced perfectly below but bearing an impressed line above, and bearing on each side a "flower," both spathes being well developed but placed back to back, the open ends therefore facing away from each other. The spadix in each case bore only ovaries. It will be seen at once that this is a case similar to many of those mentioned in the case of the elms, where by dédoublement two leaves appeared at one node, and each leaf bore a bud in its axil, only in the case of the Indian turnip the dédoublement has not gone to the extent of perfect separation of the parts.

Podophyllum peltatum. The numerical floral plan given by Eichler in his Blüthendiagramme, 2: 137, based upon the work of Payer and Baillon, assumes a ternary arrangement of the stamens, of which the outer circle contains *three stamens*, and the inner *nine stamens in three groups* of three stamens each, each group being considered a single but compound stamen. That this is not a correct interpretation can be readily seen by one having access to abundant fresh material. The typical plan is undoubtedly ternate (fig. 4). As is well known from aberrant occurrences and from other species, the leaves are not truly opposite, but alternate, the terminal flower having on this account the appearance of appearing higher up on the side of one of the petioles. This fact has been emphasized in the diagrams. The three bracts and six sepals are introduced in accordance with the interpretation of Asa Gray, which accords with the general ternate structure of the petals and stamens. The position and number of the petals and stamens and of the placenta of the ovary are taken from an occurrence actually at hand at the time the drawing was prepared. There are evidently three petals, with which decussate three more petals, and with these as a whole decussate first six stamens, and then again six stamens. Nothing can be more improbable than the peculiar occurrences of ternary dédoublement assumed by these distinguished authors.

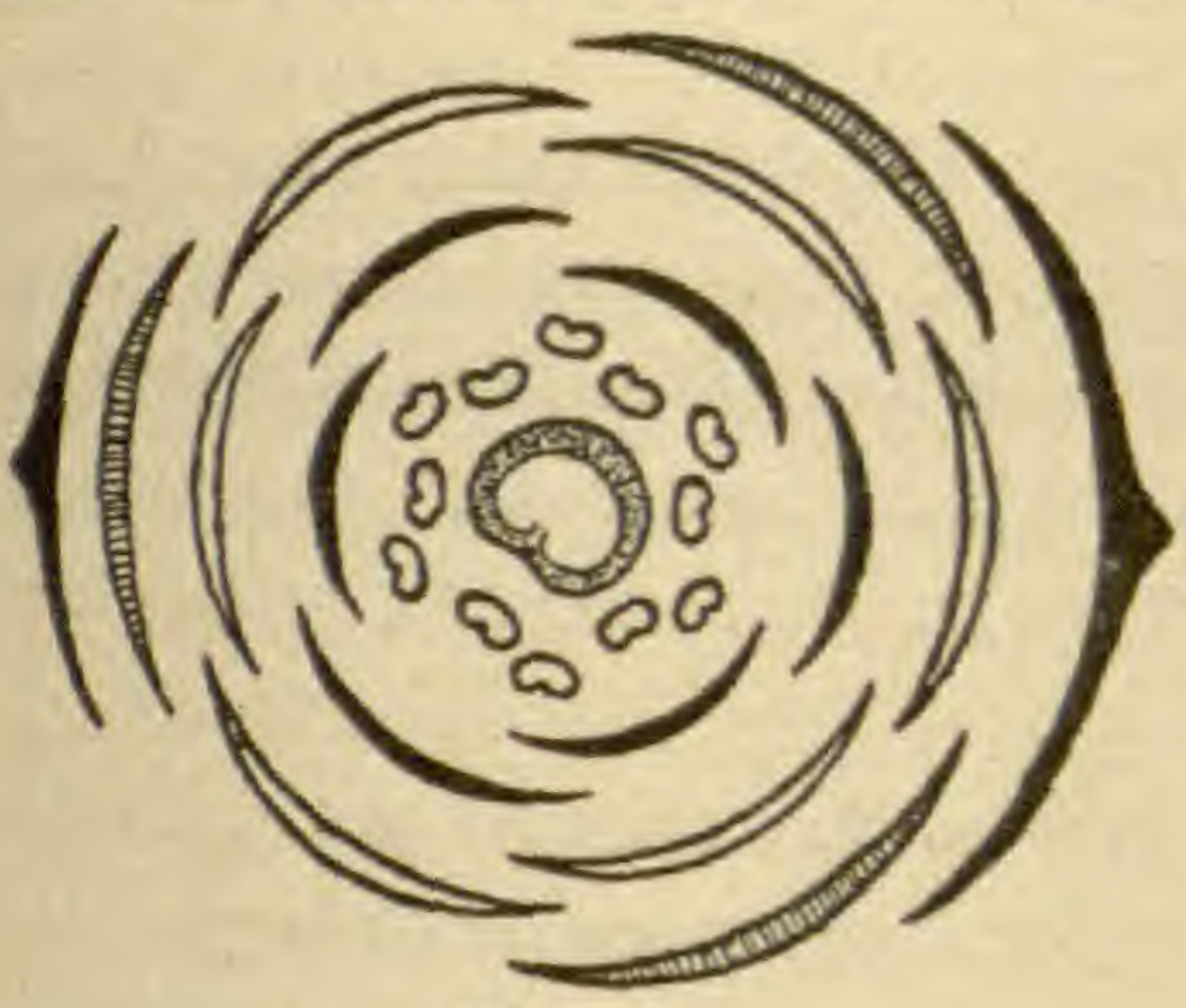

Fig. 4.

Dayton, Ohio.

BRIEFER ARTICLES.

New genus of Umbelliferæ.—WITH PLATE XXXII.—Mr. John Donnell Smith has recently sent us from his last collection in Central America a new genus of Umbelliferæ. This is a most peculiar plant, not closely related to any known genus, nor is it easily referred to any tribe. It becomes a small tree fifteen feet high and is the only arborescent species which we have seen from North America. Only two plants were seen, growing at an altitude of 10,200^{ft} and constituting the highest vegetation on the volcano.

This is the third genus of Umbelliferæ that has been brought to light by Mr. Smith in Central America. We have previously reported upon Guatemalan Umbelliferæ in this journal for January and October, 1890, and February, 1893.

Myrrhidendron, genus nov.—Calyx teeth obsolete. Fruit linear, flattened dorsally, glabrous, shining. Carpels strongly flattened dorsally; dorsal and intermediate ribs low; lateral ribs narrow-winged. Stylopodium low conical. Oil-tubes solitary in the intervals, two on the commissural side. Seed strongly flattened dorsally, with a flat face and furrowed under the oil-tubes.—Arborescent. Leaves large, decompound; leaflets ovate. Flowers white.

A peculiar genus, with fruit of the shape and texture of *Myrrhis* but differently flattened. The carpels are flattened as in *Peucedaneæ* but in other respects unlike that tribe.

Myrrhidendron Donnellsmithii sp. nov.—A small tree 3.6 to 4.8^{m} high; trunk 7.5^{cm} in diameter: leaves large, 30^{cm} or more long, ternately compound; leaflets ovate to lanceolate, 2.5 to 5.0^{cm} long, acute, sharply and often irregularly serrate, the teeth more or less mucronate-tipped, glabrous, shining and impressed veiny above, dull and paler beneath and conspicuously reticulate; petiolules with a prominent stipular ring which is more or less glandular tufted; petioles large, inflated: peduncles short: involucre few-leaved; involucels numerous, 3- to 4-toothed or cleft near the apex, scarious margined and strongly purplish veined: inflorescence more or less glandular puberulent; rays numerous, rarely equal; pedicels 8 to 10^{mm} long: fruit linear, 10 to 12^{mm} long, glabrous.—From the lava beds at the summit of the volcano Irazii in the province of Cartago, Costa Rica, March, 1894 (no. 4,825).—JOHN M. COULTER and J. N. ROSE, *Lake Forest, Ill.*, and *Washington, D. C.*

Completoria complens Lohde.—This very interesting parasite of fern prothallia has not, heretofore, I believe, been reported as occurring in the United States. It was found by me last winter in fern prothallia grown in the Botanical Conservatory of Cornell University. The fungus is very interesting both from its relationship with the *Entomophthoræ* and from its being a parasite in plants. It is of very simple structure.

The germinating conidia do not enter the cells of the prothallia directly, but put out a short germ tube which enlarges at its end, and into this enlarged end the protoplasm migrates, thus forming a germinating vesicle or proembryo. From this germinating vesicle the tube arises which penetrates the cell of the prothallium. The cell wall forms a sheath around the entering tube and the wall here becomes reddish brown. The tube, which is quite slender, grows directly to the center of the cell lumen where it enlarges into a flask-shaped body, rich in protoplasm, very granular, and with large vacuoles. From this a short and thick branch grows out and curves more or less closely to the parent cell or hyphal body. Successive branches of a similar kind arise and curving around form a closely compacted botryose cluster, which eventually more or less completely fills the cell lumen. From the marginal cells of this cluster slender tubes arise which penetrate into the adjacent cells. Conidia and sexless (?) resting spores are formed.

In the formation of the conidia certain of the marginal cells of the botryose cluster grow through the wall of the prothallium cell to the exterior, where a single-spored sporangium is formed, either quite close to the surface of the prothallium when the conodiophore is very short, or at a little distance from it when it is longer. The conidium is thrown off with considerable force as in the other *Entomophthoræ*, and the basal end protrudes slightly as a prominent point. If the conidia are not in a favorable position for entering the cells of a prothallium, or the surrounding conditions are unsuitable for it, it may produce a short conidiophore and a secondary conidium be thrown off. This may quite likely be repeated several times.

The resting spores are formed from the central cells of the botryose cluster, and may vary in a single cell of the prothallium, and thus in a single cluster, from one to ten or fifteen. These cells become larger than the others, gradually round off, the protoplasm contracts somewhat and at the same time the wall thickens inward. The appearance of many of the outer cells in such a cluster suggests the possibility of there being a sexual process, but in no case have I seen any communication between these cells, although I have carefully examined many. This however may have been overlooked because of the difficulty of observation in such a large mass of cells.

The fungus was found in prothallia of *Aspidium falcatum*, *Pteris argyria*, and *P. cretica*.

It was first described by Lohde.[1] Subsequently Leitgeb[2] made it the subject of a thorough investigation, and grew it in a large number of species of fern prothallia.—GEO. F. ATKINSON, *Ithaca, N. Y.*

Lemna Valdiviana in Massachusetts.—Several interesting botanical excursions have been made this year in the lands recently set apart by the state of Massachusetts for public parks.

By notice sent out by the superintendent of planting for the parks, the local botanists have had the opportunity of enjoying a series of pleasant field days and comparing the work done in different portions of the reservations.

One such trip was taken on Sept. 3d through the Blue Hills region, eight miles south of Boston. This public park is thirteen miles in circumference and includes the highest land in eastern Massachusetts (Blue Hill, 636^{ft}), as it is also the highest land on the Atlantic coast from southern Maine to Florida. It has long been locally famous for its rocky ledges, basin-like swamps, and, on its southern side, the extensive meadows and ponds of two sorts, rocky, with clear waters, and marshy, with dark waters.

The most interesting find on that occasion was a Lemna, which, so far as comparison with specimens at the Gray Herbarium shows, is *Lemna Valdiviana* Philippi; and I send this note of its occurrence so far north of its usual habitat, and would be very glad to have some southern or western *L. Valdiviana* in exchange.—GEO. G. KENNEDY, *Readville, Mass.*

Puccinia malvacearum.—Some years ago, the late Geo. W. Clinton of Buffalo, N. Y., expressed himself as disappointed because a certain Ranunculus did not turn out to be R. bulbosus. "Why can't Buffalo have this plant?"

We have rather desired at this place the presence of living Puccinia malvacearum, because it was so useful for the class room. This year, for the first time, it has been introduced with some hollyhocks purchased at the east. It has already made serious attacks on half a dozen species of plants in our botanic garden and now that we have it, the thing doesn't seem so funny.—W. J. BEAL, *Agricultural College, Mich.*

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[1] Tagblatt der Naturforscherversammlung zu Breslau, 1874.

[2] Sitzungsbericht der Math.-Naturwiss. Classe d. kaiserliche Akademie der Wissenschaft. Wien **84**[1]: 288. 1881.

CURRENT LITERATURE.

The Flora of Nebraska.[1]

The members of the botanical seminar of the University of Nebraska have undertaken not only a botanical survey of the state, but have begun the publication of a flora on an elaborate and costly plan. The first two parts of the twenty-five promised have recently been issued and are an earnest of a most admirable work. The brief introduction prepared by Dr. C. E. Bessey (who, we doubt not, is the inspiration of the undertaking) gives an account of the principles of classification of the vegetable kingdom. The first part, embracing sixty-eight pages and twenty-two plates has been prepared chiefly by Mr. De Alton Saunders, who describes the green plants belonging to the Protophyta and Phycophyta; while Messrs. Roscoe Pound and Frederick R. Clements describe the fungi of these groups. The second part, on the Coleochaetaceæ and Characeæ, has been done by Mr. Albert F. Woods, and consists of nine pages of text with fourteen plates.

Of the accuracy of this work only a specialist can judge and we do not undertake to pronounce upon it; but however many slips there may be, or however crude the critical work may be, it can hardly be doubted that the publication will be of great value in making known the flora of the state not only to those outside it but much more to those inside it. That it begins with the plants it does (or even treats them at all) will be a revelation to many a teacher, who thinks of these as plants to be sure, but hardly as plants which can be described, much less identified, by ordinary mortals.

A word of commendation should be said for the plates. The drawing, engraving and printing are all excellent and they contribute much to the value of the work. Not all the species are represented of course. No principle of selection is stated and we are unable to discover what it is beyond that of figuring at least one species of each genus. So many of the species are thus shown that the plates add immensely to the helpfulness of the text.

Nebraska is in peculiar need of a local flora, since it lies at the junction of the Rocky Mountain and prairie region, and even the published

[1]Flora of Nebraska. Edited by the members of the botanical seminar of the University of Nebraska. 4to. Introduction, by Charles E. Bessey. Part 1, Protophyta-Phycophyta, by De Alton Saunders, pp. 1–68. pl. 1–22. Part 2, Coleochætaceæ, Characeæ, by Albert F. Woods, pp. 119–128. pl. 23–36. Lincoln, Neb. Published by the Seminar. 1894. Per part, $1.00.

floras of the spermaphytes do not adequately cover its territory, to say nothing of the entire lack of manuals for the lower plants.

We congratulate the people of Nebraska therefore, on the auspicious beginning of this work. We commend the disinterested labors of the botanical seminar to public support by the appropriation of public moneys for maintenance and extension of the botanical survey. No state, so far as we are aware, has ever had such work done at private cost, and we doubt not that a small appropriation would not only greatly encourage these unselfish students of the Nebraska flora, but greatly facilitate and extend their work.

Minor Notices.

PROF. W. W. BAILEY'S Botanical Note Book will surely be welcomed by those who intend giving a course of lectures on structural and systematic botany in relation to the phanerogams, and conducting classes in laboratory work in the same subject. The book is divided into two parts. The first part consisting of outlines of lectures on the seed, root, stem, leaves, inflorescence, flower, essential organs, and fruit. Each lecture is followed by a schedule for the description of the parts treated in the lecture.

The schedules consist of questions, and lines of investigation to be followed by the student. Part two is devoted to lectures upon certain difficult families or genera with schedules for their study. These are arranged in the same general way as the preceding, and include Compositæ, Umbelliferæ, Cruciferæ, Gramineæ and Ferns (with the genera Carex and Cyperus.) The framework of an introductory lecture on the subject of botany in general precedes the whole. The book is of handy size, 6¾ by 4½^{in}, and is bound in strong flexible covers. It will be a welcome addition to the laboratory, and a practical help to the instructor.—WALTER DEANE.

THE PROCEEDINGS of the Indiana Academy of Science for 1893 contain much botanical material, chiefly in connection with the work of the State Biological Survey. Professor Underwood, the botanical director of the survey, gives an account of the work, followed by a complete bibliography of Indiana botany, a list of cryptogams at present known to inhabit the state of Indiana (about 650), containing descriptions of some new species, and complete lists of hosts in the case of parasites. Among the botanical papers published in full are a general consideration of the phanerogamic flora of the state, by Stanley Coul-

[1]BAILEY, W. W.—Botanical Note Book. A synopsis of lectures and laboratory plans for use in Brown University and University Extension classes. Providence, R. I. Preston and Rounds, 1894.

ter; the special senses of plants, a presidential address by Dr. J. C. Arthur; notes on Saprolegnia ferox, by Geo. L. Roberts; the ash of trees, by Professor M. B. Thomas; our present knowledge of the distribution of pteridophytes in Indiana, by Dr. Underwood; the adventitious plants of Fayette county, by Robert Hessler.

RACIBORSKI has studied the morphology and development of the shoots and flowers of the Cabombeæ and Nymphæaceæ. His results appear in *Flora*, 78: 244–279. 1894, and his paper has been distributed also as a separate, *repaged*. The editor of *Flora* ought not to permit this, even if the publisher knows no better than to do it. When will such bibliographical sins cease?

THE DEPARTMENT of botany of the British Museum has had prepared a "Guide" to Sowerby's models of British fungi now in the possession of the Museum. All the species are described and many figures are given. The guide forms a brief compend of the larger and more common edible and poisonous fungi of Britain.

MR. EDWARD A. BURT has worked out the histology and development of a new species of the imperfectly known phalloid genus Anthurus, *A. borealis* Burt. He characterizes the species, and describes his investigation in the *Memoirs* of the Boston Society of Natural History, 3: 487–505. *pl. 49, 50*. O 1894.

ANOTHER of the useful keys to Manhattan (Kans.) plants, by Professor Hitchcock, has appeared. This one is based upon fruit characters, and will be found valuable for winter study.

NOTES AND NEWS.

DR. H. MOLISCH has been called to the German University at Prag as professor of anatomy and physiology of plants and director of the physiological institute.

THE DEPARTMENT OF AGRICULTURE has issued a bulletin on "nut grass" (Cyperus rotundus), regarding which Mr. Dewey, assistant botanist, desires information.

THE ACADEMY OF SCIENCES at Berlin has appropriated 500 marks for the prosecution of the work of the International Commission for the reform of botanical nomenclature.

DR. EDWARD PALMER has gone to Acapulco, Mexico, where he expects to make a collection of plants. He goes at his own expense, but his plants will be named as heretofore by Mr. J. N. Rose of the Department of Agriculture.

IN THE *American Naturalist* (August) Professor L. H. Bailey publishes a paper on "Neo-Lamarckism and Neo-Darwinism," in which these varying schools are defined, and exceptions taken to Weismann's theory of the continuity of the germ-plasm, as well as his sweeping claims concerning acquired characters.

IN THE *Zeitschrift für Pflanzenkrankheiten* 4: 5. 1894, Jacob Eriksson and Ernst Henning describe a new Puccinia (*P. dispersa* Eriks. & Henn.), from Sweden. The æcidium stage is found upon two species of Anchusa. The uredo and puccinia stages occur on at least eleven species of Gramineæ, including several of the cereals.—L. S. C.

DR. HARSHBERGER's note (p. 159) concerning *Ranunculus acris* L. as being poisonous tells an old story. In many places, beggars used to rub their hands with this plant, in order to make them sore and thus obtain alms. For this reason the Danish name of the plant is Tigger-Ranunkel (beggar-r.). The Kräutterbücher and old floras know a great deal about this plant.—J. C. BAY.

IN THE October number of *Forstlich-naturwissenchaftliche Zeitschrift* appears the concluding part of "Contributions to the history of development of buds in some deciduous trees," by Dr. Paul Albert; "Investigation of the morphology and anatomy of malformations upon shoots and leaves caused by the Exoasci," by W. G. Smith; and "The capacity of oak stumps for budding, and their infection by *Agaricus melleus*," by Dr. Robert Hartig.

MESSRS. Frank S. Collins, William A. Setchell, and Isaac Holden have made preparations for the issuing of sets of dried specimens of the North American algæ, both of the fresh and of the salt waters, for the aid of investigators, and to assist in the development of a better knowledge of the North American species. Contributions of sets of eighty specimens each are solicited. All interested are requested to address Frank S. Collins, 97 Dexter St., Malden, Mass.

THE BELGIAN ACADEMY of Sciences at Brussels has offered prizes tothe value of 600 francs for the best treatise on the following themes:

(1) Researches on the number of chromosomes before fertilization in any animal or plant; (2) New researches on the quaternary flora (of Belgium) and especially on the peat bogs; (3) Is there a nucleus in the schizophytes, and if so, what is its structure and the mode of division? Theses must be written in French or Flemish and sent under a fictitious name before August 1st, 1895, to Chev. Edm. Marchal, secretary of the Academy.

M. JULES FERDINAND LUND has found[1] that the age of tubers influenced the effect of dessication upon their respiration. In old tubers collected in the preceding season which had been kept over winter, he found that respiration diminished with the diminution of the water; but when he operated with young tubers collected in April or in May and formed during the season, he found respiration augmented by a rather feeble loss of water.

Dr. J. GRUESS of Berlin publishes an extensive paper in Pringsheim's *Jahrbücher f. wiss. Botanik* (26: 379–437. 1894) on the behavior of the diastatic enzymes in seedlings. He holds, in brief, that diastase (or a certain sort of it) behaves in germination in the same way as the sugar, passing from cell to cell as needed. In growing tissues it behaves somewhat differently, for it is stored up there, and is probably used for the solution of the transverse walls in the formation of the tracheæ. Grüss holds it as certain that diastase belongs to the bodies capable of diffusion.

M. LUCIEN DANIEL has been making a thorough study of herbaceous grafting. He has not only studied the subject from the morphological and physiological point of view[2] but now suggests[3] a series of principles for the practical application of herbaceous grafting. He finds it possible to vary the flavor of legumes by grafting on a plant having a different flavor; to retard the flowering of crucifers (and so to avoid hybridization by insects, etc., when it is desired to keep varieties pure); and to create new varieties by grafting after seed formation. He has not been able to graft etiolated herbaceous plants.

THE CAUSES of the arrangement of leaves has long been one of the problems for study of physiologists and many contributions has been made to the subject. Dr. Hermann Vöchting publishes in Pringsheim's *Jahrbücher f. wiss. Botanik* (26: 438–494. 1894) a paper on the effect of light in determining the form of the leaf-like Cactaceæ, which he concludes by a discussion of the theory of leaf arrangement. He was able to modify at will the form of these plants, not only altering the leaf arrangement but even the stem structure from isobilateral to radial. The genus chiefly used, Phyllocactus, Vöchting believes to be a very modern one, and the changes induced in it by altering the light to be artificial reversion. In these leaf-like Cactaceæ, therefore, he concludes that leaf arrangement is due to the influence of light upon

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[1] Revue Gén. de Bot. **6**: 353. 15 S 1894.

[2] Recherches morphologiques et physiologiques sur la greffe. Rev. Gén. de Bot. **6**: 1894.

[3] Sur quelques applications practiques de la greffe herbacée. Rev. Gén. de Bot. **6**: 356. 15 S 1894.

the growing point. It is not a phenomenon of secondary growth. It may be that in other plants other external agents, notably gravity, produce an effect, and he promises investigation of this and similar questions.

THE FILSON CLUB of Louisville, Ky., has in press for publication in January "The life and writings of Constantine Samuel Rafinesque" by Dr. R. Ellsworth Call. The memoir had its inception in an attempt to clear up certain matters connected with the synonymy of the *Unionidæ*. A number of very remarkable facts connected with the personality of its subject were thus incidentally learned and the author became convinced that Rafinesque had not been always fairly treated by his contemporaries, and that many naturalists now living had formed opinions concerning the nature and value of Rafinesque's work which are quite erroneous. The volume will be in the sumptuous quarto form adopted by the Filson Club, the edition limited to five hundred copies, and issued in paper only. It will contain several full-page illustrations, one of which will be a portrait of its subject. A complete bibliography of the writings of Rafinesque, on every subject, comprising over four hundred titles, will be included.

VERY CONSIDERABLE changes and advances are being made in the department of botany at Smith College. Two years ago a new botanic garden was founded on the college grounds which were laid out for the purpose by Messrs. Olmsted and Elliot. One portion of the grounds is occupied by the herbaceous garden and green house while the remainder, including the campus, is being planted with trees and shrubs grouped principally in their natural orders, but at the same time with regard to artistic landscape effects. The attempt is therefore being made to combine as far as possible the ornamentation of the grounds and buildings with a natural botanical arrangement. The department has been further strengthened by the establishment of a new professorship, to which Dr. William F. Ganong, formerly instructor in botany in Harvard University and lately a student with Goebel at Munich, has been appointed. The former instructor in botany, Miss Grace D. Chester, has been made instructor in cryptogamic botany. The laboratories have been liberally equipped with additional apparatus, and new courses, including graduate work, are being offered.

DR. MORITZ TRAUBE, one of the many genial naturalists who lived and worked at Breslau, Germany, died on the 28th of June. Traube was born at Ratibor and studied at the University of Berlin. His brother, Ludwig Traube the distinguished clinic, was engaged in medical researches when the younger brother arrived at Berlin; when the latter had been made doctor, he worked on the question of diabetes mellitus, mainly from the chemical point of view. But his life's great work was that on the organization of the cell, and on the processes of fermentation and putrefaction. In this connection, we recall his *Theorie der Fermentwirkungen* (1858), his *Experimente zur Theorie der Zellbildung und Endosmose* in Reichert's and Du Bois Reymond's *Archiv.* —: 87. 1867, and his many valuable papers in the *Berichte der deutschen chemischen Gesellschaft*, 1874, 1876, and later. His work on the production of oxygen by the organism caused a long and most interesting literary debate between him and Hoppe-Seyler. Traube was unable to devote more than a part of his time to investigations, because he conducted the wine business started many years ago by his father at Ratibor. During the last years of his life, Traube lived in Berlin. Since 1886 hehas been member of the Berlin Academy of Sciences. His name will long be remembered in cellular physiology. —BAY.

AS A SEQUEL to his investigations on the origin of the haustoria of Cuscuta and their penetration of host plants, Mr. G. J. Pierce has sought to discover whether common roots have the power to penetrate living tissues.[1] By enclosing seeds of Brassica napus and Sinapis alba between halved potato tubers he found the roots able in twelve days to penetrate the half and even to pass out through the cork layer. On such roots, as on those grown in plaster casts, no hairs develop, which is probably due to the resistance of the medium. The passage made by the root was surrounded by torn, compressed, dead, brown-walled cells, which were enclosed by two or three rows of cells forming new walls parallel to the course of the wound. He found no corroded starch grains, àpropos of which he remarks that the observations of Prunet on the penetration of potato tubers by rhizomes of Cynodon Dactylon may be explained on other grounds than the excretion of a diastatic ferment. Similar results were obtained with the thicker roots of Pisum and Vicia Faba. In three days the pea roots had penetrated 7.5^{mm} without any corrosion of starch. These and other experiments seem to show that the penetration was due to mechanical pressure exerted. Seedlings of the pea were cemented to branches of Impatiens Sultani, a leaf of Echeveria sp., an almost ripe ovary of Fritillaria, a petiole of Rheum officinale, a leaf of Aloe, and a stem of Euphorbia lucida. In all these cases the roots penetrated the superficial tissues to the inner. So the ability and the force needed to penetrate living tissues is not peculiar to the specialized roots of Cuscuta, but is possessed by ordinary plants.

PFEFFER HAS demonstrated that it is the root alone which possesses geotropic sensitiveness. "All previous investigations have been inconclusive because they were judged of by the results which followed cutting off the tip of the root. . . . As regards heliotropism the state of things is easily demonstrated, since the rays of light that act as a stimulus can be easily directed to a single point. On the other hand, it can hardly be thought practicable to expose the root tip alone to the stimulus of gravitation, or in place of this to centrifugal force. We attained the end in another way, however, namely, by compelling the tip of a root, whilst growing quite normally, to take up permanently a position at right angles to the rest. For this purpose we allowed roots of Faba, Lupinus, etc., to grow into short tubes of thin glass that were bent at a right angle. The advancing root easily follows the bend of the tube, and pushes on as far as the other end which has been closed by heat. . . . A geotropic reaction only follows when the tip of the root is not placed in the position of equilibrium, that is, when it is inclined from the vertical. But if the tip is directed

[1] Botanische Zeitung **52:** 169. 1894.

vertically downwards, the rest of the root may occupy the horizontal or any other position, without the geotropic reaction following. By this means, therefore, it is proved with the most perfect certainty that in an uninjured root only the root tip is geotropically sensitive."[1]

"A THEORY of the strobilus in archegoniate plants" is the title of a most suggestive paper read by Dr. F. O. Bower before section D of the B. A. A. S., and published in the *Annals of Botany* 8: 343-365. S 1894. It ought to be read in full by every botanist who is interested in the questions of vegetable phylogeny. The main points of the theory are briefly stated by the author in these words:

1. Spore production was the first office of the sporophyte, and the spore phase has constantly recurred throughout the descent of the Archegoniatæ; the spore bearing tissues are to be regarded as primary, the vegetative tissues as secondary, in point of evolutionary history.

2. Other things being equal, increase in number of carpospores is an advantage; a climax of numerical spore production was attained in the vascular cryptogams.

3. Sterilization of potential sporogenous tissue has been a widespread phenomenon, appearing as a natural consequence of increased spore production.

4. Isolated sterile cells, or layers of cells (tapetum), served in many cases the direct function of nourishing the developing spores, being themselves absorbed during the process.

5. By formation of a central mass (columella, etc.) the spore production was, in more complex forms, relegated to a more superficial position.

6. In vascular plants, parts of the sterile tissue formed septa, partitioning off the remaining sporogenous tissue into separate loculi.

7. Septation to form synangia, and the subsequent separation of the sporangia, are phenomena illustrated in the upward development of the vascular plants.

8. Such septation may have taken place repeatedly in the same line of descent.

9. The strobilus as a whole is the correlative of a body of the nature of a sporogonial head, and the apex of the one corresponds to the apex of the other.

10. Progression from the simpler to the more complex type depended upon (*a*) septation, and (*b*) eruption to form superficial appendicular organs (sporangiophores, sporophylls), upon which the sporangia are supported.

11. By continued apical growth of the stobilus the number of sporophylls may be indefinitely increased.

12. The sporophylls are susceptible of great increase in size and complexity of form; in point of evolutionary history, small and simple sporophylls preceded large and complex ones.

13. In certain cases foliage leaves were produced by sterilization of sporophylls.

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[1] Annals of Botany, **8**: 317. S. 1894.

C. E. Faxon, del.

B. Meisel, Lith. Boston.

MYRRHIDENDRON DONNELLSMITHII Coult. & Rose.

SCHAFFNER on ATTRACTION-SPHERES.

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THE

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In the January number will appear:

Undescribed plants from Guatemala and other Central American Republics. XIV, by JOHN DONNELL SMITH, *Baltimore, Md.*

The crystallization of cellulose, by DUNCAN S. JOHNSON, *Johns Hopkins University, Baltimore, Md.*

Notes from my herbarium. I, by WALTER DEANE, *Cambridge, Mass.*

Noteworthy anatomical and physiological researches.

BOTANICAL GAZETTE

DECEMBER, 1894.

Contribution to the comparative histology of pulvini and the resulting photeolic movements.[1]

FRED DE FOREST HEALD.

WITH PLATE XXXIV.

Since the work that I have already completed upon the comparative histology of pulvini and the resulting photeolic movements is too extended to permit of presentation in these pages, the large mass of details in connection with each species will be passed over, and only an outline of the work carried out will be here attempted. The complete paper will be published elsewhere later.

Aim of study.

Inasmuch as the majority of investigators have busied themselves with seeking an explanation of the movement of leaves with motor organs without paying very great attention to their histology, the literature dealing with the structure of the pulvinus is comparatively scanty. The present work was undertaken as a contribution to the comparative histology of motor organs, hoping that a better knowledge of their structure might aid in understanding their physiology.

The work that I have already done seems to indicate that the presence of motor organs is much more general than was at first supposed. Not only the material collected, but observations in connection with the field work confirm this opinion. It remains for further study to reveal to what extent the supposition is correct.

In connection with the anatomy of the organs I have sought to give a general idea of the positions which the leaves assume at night. It was not considered necessary to measure the exact angles which the petioles form with the axes nor the angles of the leaflets with the rachis in the diurnal and

[1] Abstract of a thesis for the degree B. S. in Botany, University of Wisconsin, June, 1894.

nocturnal positions, since the angles vary with different individuals, and with the same individual at different times. All that was sought was the general extent and direction of the movements.

I pass over the account of earlier investigations which forms the historical introduction to my paper and set forth the

Present state of knowledge as to the physiology of the motor organs.

Pfeffer[2] found that the rise of the leaves of Phaseolus, when assuming the night position, was brought about by the increase of the turgidity of the cells of the lower half of the pulvinus and a diminution of the turgor of the cells in the upper half; the reverse occurs when assuming the day position. From this it is evident that changes of an opposite nature take place simultaneously in the cells of the two opposed halves of the pulvinus.

There are three ways in which the change of the hydrostatic pressure might occur: (1) by a change in the osmotically active substances of the cell sap; (2) by a change in the elasticity of the cell-walls; (3) by a change in the resistance of the protoplasm to the escape of cell sap. The first two are shown by Vines[3] to be out of the question, and the third remains as the explanation of the changes in turgidity. With illumination comes the restoration of the protoplasm to its original condition, and the absorption of water into the cell. The change in the protoplasm being entirely invisible, it may be inferred that there occurs a rearrangement of the molecular structure or possibly the breaking down of the protoplasmic molecule. In the latter case the restoration of the original condition would simply be the building up of the protoplasmic molecule. Briefly, the mechanism of the movement may be stated as variations in the degree of turgidity of the opposed halves of the motor organs, in accordance with changes in the molecular structure of the protoplasm. The molecular changes are brought about under the influence of the alternation of light and darkness.

In connection with this subject I must mention the work of Haberlandt[4] on the conduction of "stimuli" in Mimosa

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[2] Pfeffer; Die periodischen Bewegungen der Blattorgane 166. 1875.
[3] Vines; Physiology of Plants 62–64. 1886.
[4] Haberlandt; Das reizleitende Gewebe-system der Sinnpflanze. 1890.

pudica. His investigations contradict those of Dutrochet[5] and others. He finds that the impulse normally travels inside the collenchyma ring but outside the xylem of the bundles, in other words, in the phloem. When a stem is cut, drops come from special cells in the phloem and not from the xylem as was formerly supposed. The phloem of Mimosa, like that of many of the leguminous plants, is characterized by rows of somewhat larger cells than the true sieve-cells, which from the nature of their contents are known as tannin cells. He concludes that the impulse is transmitted by these rows of glucoside cells, and that in a purely mechanical manner. This is against the theory of Vines[6] that the impulse travels by the continuity of the living protoplasm, for Haberlandt found that the impulse could be transmitted through parts that had been killed by steam.

A few words in regard to what Vines terms[7] the transmission of the "stimulus." In accordance with animal physiology the use of the term is incorrect. It is not the stimulus that is transmitted but the stimulus upsets the equilibrium and the resulting impulse is transmitted. Heat as heat is not transmitted, a mechanical force as such is not transmitted, but each gives rise to impulses that are transmitted. Why then in the case of plants like Mimosa is it not the impulse from the stimulation which sets off the cells of the succeeding motor organs and causes the leaflets to fold together? We should speak of the transmission of impulses and not stimuli and in one more way unify the two sciences.

In order that we may obtain a correct idea of the movements to be dealt with, a short outline of the movements of plant organs is here given. Passing by the movements of growing organs, or auxotonic movements, which do not specially concern us, there are the movements of mature organs, or allasotonic movements, which comprise the following:

1. Spontaneous movements, resulting from conditions which we are unable to interpret.

2. Induced movements, or those resulting from stimulation. According to the nature of the stimulus we distinguish those due

[5] Vines; Physiology of Plants 583. 1886.
[6] Vines; *op. cit.* 584–587.
[7] Vines; *op. cit.* 582.

a. To variation in the intensity of light. Called "sleep movements;" "nyctitropic movements;" "variation movements." (Pfeffer.)

b. To variations in temperature.

c. To mechanical stimuli.

d. To electrical stimuli.

e. To chemical stimuli.

f. To intensity and direction of light, or para- and diaheliotropism.

Suggestions on terminology.

The phrase "sleep of plants" is, of course, entirely fanciful. Even as far back as the time of Senebier it was known that this Linnean phrase was not scientifically correct, yet it has continued in quite frequent use even up to the present time. The movements have also been called nyctitropic movements, among which Darwin includes the nutation movements of growing leaves. Even if we confine this term to the movements of plants with motor organs, the term is still not a good one. Etymologically it means night-turning movements; now from the nature of the movements, it is evident that since the leaves assume a different position at the approach of day, it would be just as proper to use a term meaning day-turning movements. For this reason it seems to me that some other term would be better. Since we know the real cause of the movements, the gradual variation in the intensity of the light, would not a word expressing that be better? For this reason I propose the term photeolic movements, from the Greek *φως* meaning light, and *αιολος*, variable. This term would be only applicable to movements of leaves which have special motor organs, and not to those similar movements which are auxotonic.

One more point in regard to the terminology, for it seems to me to be of importance that we use terms that are scientifically correct. The special organ of motion is commonly called, "the motile organ," or the "pulvinus," which is the same as the "Gelenkpolstern" of the Germans. In his paper on "The mechanism of movement in Cucurbita, Vitis and Robinia," Penhallow[8] speaks of tendrils as motile organs. We can not deny him the right to use this term, for tendrils certainly are motile organs. Here then is a confusion of a com-

[8] Penhallow; Mechanism of movement in Cucurbita, Vitis and Robinia. 49. 1886.

mon term, using the same for two very different structures. Burdon-Sanderson[9] speaks of the organs as "motor organs." I do not know whether it was a mere accident on his part or a premeditated change, but as he states no reason for so doing, I judge that it was the former. It is, however, a happy suggestion and therefore instead of the term which is in such common use, motile organ, I propose to adopt the term motor organ for those structures whose curvatures set in motion other passive parts. In electro-mechanics it is the motor that drives the machinery. Now the motor organ, like the electric motor, causes other structures to move, the leaf being passive and taking whatever position is necessitated by the curvatures of the motor organ. This, then, seems to me to be an especially good term, and in adopting it we shall avoid confusion in the minds of those who do not command a view of the whole subject.

Method and material.

The material for the work on this subject was collected during the summer of 1893, in the months of June, July and August. At the same time that the collection of material was made the positions of the leaves were noted. A small case containing bottles of Flemming's fluid was carried into the field; the specimens of motor organs were snipped off with a pair of scissors, leaving only such additional parts of leaves, petioles and axes as were necessary for examination, and placed immediately in the fixing fluid. The plants were visited during the day, the position of the leaflets noted, and material collected. They were again visited about dark, and specimens of the organs in their nocturnal position were obtained; at the same time a record of the position of the leaflets was made. Some leaves were slow in assuming their nocturnal position, and in those cases it was necessary to visit them later in the evening. In thus taking the observations from field specimens, I avoided the danger of vitiated observations which are possible in studying a plant out of its natural habitat. On the other hand the observations required considerable time and trouble because some of the species were local, and it was necessary to go to a distance in order to obtain specimens from them.

The specimens of the motor organs, which were placed in Flemming's fluid as soon as removed, were allowed to remain

[9] Burdon-Sanderson; The Excitability of Plants. Nature. **26:** 353, 483. 1882.

for twelve to twenty-four hours, or until they were perfectly fixed. They were then removed, washed with water, and carried through the different grades of alcohol up to 70%, where they were allowed to rest. Sections were cut and stained with either borax-carmine or hæmatoxylin, washed, then passed through 95% and 100% alcohol, cleared in oil of origanum, and mounted in balsam. For the study it was necessary to have transverse sections of the motor organ, of the petiole above and below the motor organ, and of the rachis; also median longitudinal dorsiventral sections of the organs in their diurnal and in their nocturnal positions. Over one hundred and fifty slides were prepared for the work. The borax-carmine stain was used for the majority, and it was found necessary to leave the specimens in the stain for about twelve hours, on account of the slowness with which they took it up.

Species studied.

Twenty-five species representing four families and seventeen genera were studied. The following is the list:

I. LEGUMINOSÆ.

Baptisia leucophaea Nutt., *B. leucantha* Torr. & Gray, *Trifolium pratense* L., *T. hybridum* L., *T. repens* L., *T. procumbens* L., *Melilotus alba* Lam., *Medicago lupulina* L., *Amorpha canescens* Nutt., *Petalostemon violaceus* Michx., *P. candidus* Michx., *Desmodium acuminatum* DC., *D. canescens* DC., *D. Canadense* DC., *Lespedeza capitata* Michx., *Vicia sativa* L., *Lathyrus ochroleucus* Hook., *L. venosus* Muhl., *L. palustris* L., *Apios tuberosa* Moench, *Amphicarpæa monoica* Nutt., *Gleditschia triacanthos* L.

II. GERANIACEÆ.

Oxalis corniculata L., var. *stricta* Sav.

III. POLYGALACEÆ.

Polygala verticillata L.

IV. MALVACEÆ.

Abutilon Avicennæ Gærtn.

Definitions.

In the descriptions which follow I have called the motor organ located at the base of the petiole the *primary organ.* In the pinnate leaves the whole of the secondary petiole or petiolule is transformed into a motor organ, this I term the *secondary organ.* (Contrast with Penhallow's paper.) In the case of bi-pinnate leaves, the petiolules of the secondary leaflets may be transformed into motor organs and these I term *tertiary organs.* The term *ventral* has been used to indicate the upper side of the organ, leaf-blade or petiole, that is, the side toward the axis in the bud, the *dorsal* being the lower side or that which is away from the axis in the bud. Following the example of Penhallow[10], I have used the term hypodermal tissue to mean the tissue between the stele and the epidermis which is derived from the periblem. Vines[11] calls this *extra-stelar* fundamental tissue. In the motor organ the pith is either pushed to one side and the cell-walls become thickened or it remains in the center of the stele; when the former is the case, the stele is generally somewhat kidney shaped in cross section, the remnant of pith occupying the depression. This depression I have termed the *hilum of the stele* in order to facilitate description. In the descriptions I have given the external appearance of the motor organs and the changes in position of leaves from normal diurnal positions to the nocturnal positions. I have then in each case given the anatomy of the organs, beginning with the primary and following this with the secondary and the tertiary organs when present.

From the twenty-five species described I select one, which though treated at greater length than the majority is best adapted for illustration.

Melilotus alba.

Melilotus alba shows well developed motor organs and consequently very marked movements. It has a primary motor organ which will be noticed as a slight thickening of the petiole just above the bract-like stipules, each of which contains a well developed schizostele. These schizosteles arise half way around the central stele of the axis and pass upwards and towards the base of the pulvinus, where just before uniting with the middle schizostele, they are almost at right angles to the axis. These three schizosteles of which the center one is the largest unite in the center as they pass through the motor organ proper. Besides being an enlarge-

[10] Penhallow; *loc. cit.* 76.
[11] Vines; Students' Text Book of Botany 146. 1894.

ment of the petiole the organ is noticeable on account of its darker green color. The secondary motor organ, as in Trifolium, constitutes the whole of the petiolule, but here there is a rachis intervening between the mesopodium and the pulvinus of the terminal leaflet. [This was referred to when speaking of Trifolium procumbens in the preceding genus.] Unlike those of Trifolium, the organs do not show any difference in size as they are continued on into the mid-rib, but shade off gradually so that their limit can only be determined externally by their difference in color. The rachis continues for about half an inch before the terminal leaflet is given off and the organ of this leaflet is a little smaller than the rachis, there being quite an abrupt change in size, as shown in plate XXXIV, figs. 1 and 2.

In the normal diurnal position the petiole forms a right angle with the internode above its insertion, and the three leaflets are spread out in a horizontal position. The leaf shows other very marked movements not photeolic, and one of these may be noted early in the morning when the sun is still in the east. The petiole curves so as to bring the plane of the laminæ at right angles to the incident rays of the sun. If the plants are visited in the late afternoon it will be found that the upper surfaces of the leaflets are similarly turned towards the setting sun. This is due to the so-called transverse heliotropism and is to be separated from the movements brought about by the variation in the intensity of light. If the plants are observed in the hottest part of the day they will be found to have assumed a position different from the one just described. The blades of the leaves are brought to occupy a position parallel to the incident rays of the sun, by turning upwards; this movement is connected with the protection of the chlorophyll from the intense rays of the sun, and is due to the so-called paraheliotropism. These movements are mentioned so that it may be understood that they are not similar to, and have not been confused with, the phot-tteolic movements.

In assuming the nocturnal position the primary petiole approaches the axis above its insertion, passing through an angle of 20–30°, thus coming to make an acute angle with the axis. The two lateral leaflets turn upwards so as to bring the upper faces together, but they never twist upon their axes. The terminal leaflet approaches the axis, sometimes directly without any twisting, while at other times a slight twist is made. They thus assume nearly the same position as the leaflets of T. repens, only the position seems different on account of the upright growth of the axis.

Darwin[12] describes the "sleep movements" of a large number of species of the genus Melilotus, and as the type of their movements, he selects a case altogether different, in that the movement is the exact reverse of what I have found in Melilotus alba, although this is one of the species that he enumerates. Special pains was taken to make sure of this movement and plants were visited again and again with always the same result. It could hardly be that Darwin made a mistake and as he mentions a similar movement in one species at a different time, it is possible that the movement may sometimes differ in the same species. From this reversion of the movement to the Trifolium type, Darwin is inclined to speculate, and regards it as an indication of the close relation of the two genera. Since all photeolic movements are either up or down I can see no basis for such speculation.

Primary organ.—The pulvinus of the petiole as seen in the cross section is kidney shaped, fig. 4, the hilum being directed upwards or towards the ventral side of the petiole. The dorsiventral diameter is about 1.4^{mm}, the lateral diameter 1.75^{mm}, while the length is only about 1.4^{mm}. From these measurements it will be seen that the organ is quite short being only as long as its dorsiventral diameter. In the diurnal position the organ has a single transverse depression on each side, that on the ventral side being somewhat closed up, but not as deep as the one upon the dorsal side. In the nocturnal position there is a marked change in the outline; the transverse depression on the dorsal side becomes less marked as the petiole approaches the axis, while the motor organ, on its ventral side, is thrown into transverse folds for its entire length, (3 or 4 folds) the depth of the depressions depending upon the degree of movement that has taken place. As a general rule the depressions are deeper at the base of the organ and become more shallow towards the distal end.

There is a gradual change in the epidermis in passing from the leaf or petiole, so gradual indeed that it is impossible to tell exactly where the cells belong to the one or the other region. The epidermal cells of the pulvinus are of about

[12] Darwin; Movement of Plants. 346, *fig. 140.* 1880.

equal dimensions radially and tangentially, but are shorter in the longitudinal direction in accordance with the general type of motor organ cells. In consequence of the thickening of the walls the cell cavities are more or less spherical, fig. 3. The epidermal cells of the dorsal side are larger than those on the ventral side. The internal walls are much thicker in the longitudinal direction than the external walls, and very much thicker than the radial walls (fig. 3). The external wall also shows longitudinal ridges as in Trifolium pratense and other species.

The cells of the hypodermal tissue are different upon the upper and under sides of the organ. Those immediately beneath the epidermis are of about the same size as the epidermal cells, but towards the center the first few cells increase in size, then there is a decrease until the central stele is reached where they are even smaller than the epidermal cells. The cells of the dorsal side of the motor organ in the region of the hilum are smaller than those of the other side and their walls are more uniformally thickened while the cell cavities are generally four sided in cross section. The remainder of the hypodermal cells are of the collenchyma type, fig 3. They are very much thickened at the corners and the middle lamellæ are very marked. The side walls, although they look thin when compared with the thickened corners, are yet very much thicker than the walls of the adjacent parenchyma. Upon the ventral side of the organ in the region of the depression, which remains permanent, the cell walls are very thick and the cells irregular in shape. In some cases the opposite walls nearly touch each other, and when the nocturnal position is assumed the cells in the region of all the transverse depressions become very much distorted in shape. In the region of the central stele there are a few intercellular spaces, but towards the periphery they are entirely absent. The cells near the axis cylinder contain an abundance of chlorophyll, but those near the surface have a less abundant supply. Like all those previously described the cells have a peripheral layer of protoplasm, with the center occupied by a large vacuole.

Cross sections of the hypopodium were cut, and the origin of the bundles from the axis which was externally indicated, was confirmed. The purely mechanical advantage of this arrangement is at once clearly seen, and when it is noted that these three schizosteles come together at the base of the pulvinus and pass through that organ as a single cylinder, separating again as soon as beyond the limits of the motor organ, one is again impressed by the mechanical advantage which is gained by this course. As shown in the cross section the central meristele is kidney shaped in agreement with the form of the organ and is entirely surrounded by a cylinder of bast fibers. (The outline is shown in fig. 4.) The cells with the thickened walls at the hilum, which are considered to represent the remnant of the pith, have very much thicker walls than the remainder of the bast fiber layer which is made up of the bast fibers belonging to the phloem of the bundles. As seen in the longitudinal section the cells at the hilum are found to be short fusiform cells, while the latter are much longer and contain straight cross partitions which are much thinner than the longitudinal walls. The phloem forms a continuous ring around the xylem except at the hilum. The xylem vessels, spiral, pitted and reticulated, radiate from the hilum and between them are well marked pith rays the cells of which are filled with granular protoplasmic contents. From the short longitudinal dimensions of the cells of the motor organ proper, it might be thought that on account of the tensions set up, the cells of the vascular bundles would likewise be shorter than elsewhere. This supposition is confirmed by observation. The pitted and spiral vessels show cross walls much more frequently than in the general bundles of the plant.

Secondary organ.—The secondary pulvinus is nearly circular in cross section, 0.7^{mm} in diameter. The length is 1.4^{mm}, i. e., twice as great as its diameter. As seen in the cross section the epidermal cells are of the same size as the hypodermal collenchyma cells but their longitudinal dimensions are less than the same of the collenchyma. The external epidermal wall is very thin and covered with a thin cuticle which shows longitudinal ridges as already described for the primary motor organ. The radial diameter of the cells is about twice their longitudinal dimension, but beyond the limits of the organ their three dimensions are about equal, or if any difference is to be detected the longitudinal is greater.

The whole of the hypodermal cells from the epidermis to the vascular cylinder show a marked regularity in size and form; they are arranged in regular longitudinal rows, but do not fit together in the manner of all those previously described but have square end walls. They are of the same collenchyma type as shown in the organ of the petiole, but the thickening at the corners is not quite as marked. In Trifolium repens the walls of the pulvinus parenchyma cells are slightly thicker than the walls of the adjacent parenchyma. A few of the cells for that organ are shown in fig. 5; as compared with those, a few cells from the organ of Melilotus alba are shown in fig. 6. The difference in the thickness of the cell walls is to be noted. The cells are about equal in their tangential and radial dimensions but their length is slightly less. No intercellular spaces whatever could be detected, but the whole of the hypodermal cells are richly filled with chlorophyll bodies, while the protoplasm always occupies the periphery with a large vacuole in the center.

In the diurnal position the organ is slightly curved and shows very marked and regular transverse wrinkles for the entire length. When the organ assumes its night position it becomes more curved; the wrinkles on the ventral side become more marked while those on the other side are to a certain extent obliterated, figs. 7 and 8. These organs are contractions rather than enlargements of the petiolule. The same distortion of the cells in the region of the transverse depressions is to be noted as in the primary organ.

The schizosteles, as they emerge from the primary organ, traverse the petiole in the position shown in fig. 9 and give off lateral branches to the secondary motor organs in which they still occupy the center. The stele with its surrounding bast fibers is circular in cross section to agree with the form of the organ itself and it shows the same remnant of pith as in previous cases. By comparing the cross sections of the steles of the petiole and motor organs, it is found that the elements have been reduced in size; the bast fibers have thicker walls and are decidedly smaller, while the sieve cells have undergone such a modification in the thickness of their walls that it is almost impossible to tell which are bast fibers and which sieve cells, so closely do the two regions merge into each other. Otherwise the arrangement is very similar to that described for the primary organ, so no further description is needed. In the rachis the schizosteles occupy the same position as in the petiole and at the end come together to form the central stele of the terminal leaflet.

Conclusion.

From the study of the twenty-five species, I have found that there are, considering their diversity, many striking resemblances in the external and internal anatomy of the motor organs, of which I here give a short summary:

1. Organs may be found at the base of the petiole, and as such they are termed primary organs. In the species considered the primary organ may be altogether absent or represented by an imperfect development. As a general rule simple leaves do not possess pulvini; but one exception has been noted in the case of Abutilon Avicennæ, in which the organ is at the base of the leaf blade, or epipodium. This, however, I consider as a primary organ. The petiolules of each leaflet of pinnate and bi-pinnate leaves are transformed into motor organs, the secondary and tertiary organs. In the case of pinnate leaves, whenever any pulvini are present, it is always these which are found, no examples being discovered in which a primary organ was present without secondary organs.

2. The organs generally show a difference in color from the adjacent tissue. In the organs containing chlorophyll the color is darker green, which it must be concluded is due to the fact that the organ contains but few intercellular spaces. The pulvini which do not contain chlorophyll are generally yellowish. This color is due to the presence of yellow coloring matter, probably xanthophyll. In all the color may be modified by trichomes, and in Abutilon Avicennæ there is a red coloring matter in the epidermal cells.

3. As might be expected, different stages in the development of the pulvini are found in the species described. All gradations, from the very simplest indication to the perfectly developed organ, are to be found. These rudimentary pulvini are always at the base of the petiole and never secondary or tertiary organs The beginning development is to be detected by the enlargement of the base of the petiole, the modification of the hypodermal cells to agree with the motor organ type, and in the convergence of the schizosteles towards the center to form a single cylinder.

4. The organs have a variety of forms in cross section. The organs of the petiole, the primary organs, are more generally kidney-shaped although they may be circular or oval. The secondary pulvini are more commonly circular or oval in cross section, but different forms occur, varying from flattened

heart shape to almost triangular. In organs which are not circular, the lateral diameter is generally the greater although the exact reverse is the case in a few species. In the majority of organs the length is generally about twice the diameter; a few however were found in which the diameter was equal to the length.

5. The epidermis is fairly well developed when compared with the adjacent epidermis, and *well* developed when compared with the remainder of the motor organ tissue. The cells are shorter in the longitudinal direction than those of the leaf or petiole and their longest diameter is generally in the radial direction. The epidermis is generally covered with trichomes but in no instance could any stomata be found within the limits of the motor organ. The hypodermal cells are always smaller than the parenchyma cells of neighboring parts. They are always very short in the longitudinal direction, while the radial and tangential dimensions are sometimes equal to each other, but as a general rule the radial dimension is the greater. The cell walls are generally thicker than the walls of the adjacent parenchyma cells, and the protoplasm always occupies the periphery of the cells. The cells may be arranged in quite regular longitudinal rows, or on the other hand the arrangement may be quite irregular. The hypodermal tissue is to be regarded homologous with the mesophyll of the leaf. There are three types of hypodermal cells: (*a*), the parenchyma type; (*b*), the collenchyma type, or those which show thickened corners in the cross section; (*c*), a type intermediate, in which the cells have walls that are uniformly thickened.

6. Very few intercellular spaces could be detected and these only near the central stele; they are very small when compared with the intercellular spaces of adjacent parts.

7. The completely developed organ is always traversed by a stele which is entire and completely surrounded by a layer of non-lignified bast fibers. The meristele, in those leaves with primary organs, arises from the axis as three separate strands; these fuse to form the meristele of the organ and so close is the union that it is impossible to make out these three in the cross section. The same may be said of the stele of the secondary organ which is simply a branch of the meristele of the petiole. The stele may be central, or pushed to one side, in which case it is excentric. The remnant of the pith may

be in the center of the stele or it may be represented by the thickened cells at the hilum, which is always on the dorsal side of the organ. Generally speaking the elements of the steles are poorly developed.

8. The well developed organ always shows marked transverse folds even in the diurnal position, which become changed when the curvature of the organ becomes greater or less. Many organs show a compression and distortion of the cells in the region of the transverse folds.

9. Some organs must be regarded as enlargements according to the old idea while others are distinctly contractions. The former is generally the case with primary organs and the latter more commonly with secondary and tertiary organs.

Madison, Wis.

EXPLANATION OF PLATE XXXIV.

All figures except fig. 5 represent Melilotus alba.

Fig. 1. Diurnal position of leaf turned towards the west.
Fig. 2. Nocturnal position.
Fig. 3. Epidermal and collenchyma cells from the cross section of the primary organ.
Fig. 4. Diagram of cross section of primary organ.
Fig. 5. Trifolium repens. Hypodermal parenchyma cells from motor organ. Longitudinal section.
Fig. 6. Cells from longitudinal section of secondary organ.
Fig. 7. Diagram of longitudinal section of secondary organ, nocturnal position.
Fig. 8. The same, diurnal position.
Fig. 9. Diagram of cross section of petiole.
Fig. 10. Diagram of cross section of secondary organ.

Two new ferns from New England.

With some observations on hybridity and nomenclature.

GEORGE E. DAVENPORT.

The unexpected discovery of a new (species) fern, whose characters show unmistakable evidence of hybridization, in Essex county, Massachusetts, by Mr. Raynal Dodge, of Newburyport, is of unusual interest and importance, as it opens up again the question of hybridity among the ferns, a question by no means as yet satisfactorily settled.

Unfortunately absolute proof of hybridity among ferns in nature is beyond our reach and we can only conjecture probable results, with possibility of error in our deductions. We must not assume that because one plant possesses certain characters in common with two others it is necessarily a hybrid, as fundamental structural characters alone are important. The innate tendency of ferns to vary must always be considered, for herein the explanation of many apparent differences and superficial resemblances will be found.

The number of fern hybrids is exceedingly small as it must necessarily be from the very nature of the difficulties surrounding germination even in normal directions.

Asplenium ebenoides is probably the best example of a fern hybrid that we have, the infrequency of its occurrence, the presence always of *Camptosorus* and *Asplenium ebeneum*, and the few plants found in the recorded stations, all going to favor the hypothesis of hybridization; yet even here the difficulty of demonstrating such an hypothesis is almost insurmountable.

The late Wm. H. Leggett wrote to me only a short time before his death that some efforts were being made to test the hybridity of Asplenium ebenoides, but the probabilities are, that the effort, if made, was unsuccessful, as no attempt of that kind has been recorded to my knowledge; and if that fern really derived its origin from two species separated from each other by generic distinctions, the presumption is wholly in favor of its sterility.

Aspidium Boottii is generally considered a hybrid between *Aspidium spinulosum* and *A. cristatum*, but the frequency of its occurrence has oftentimes caused me to doubt the soundness of that view: it is certainly very strange that those two species should be so accommodating as to intercross in so many widely separated stations under such varying conditions and always with such nearly similar results. Besides I have more than once found A. Boottii growing so far away from one or the other of its reputed parents as to almost preclude the possibility of contact.

The fern which I here bring forward for the first time, however, was found growing under such conditions, and exhibits such unmistakable characters, that there is every probability in favor of its hybrid origin. Moreover the successful cultivation in my garden during the past year of plants transplanted from their native habitation has enabled me to watch the growth and development of this fern so closely, and my convictions in regard to it have become so strong, that I should not now expect to find it growing anywhere in nature except in close proximity to *Aspidium cristatum* and *A. marginale*, whose combined characteristics it inherits.

At the same time I recognize the possibility of parent forms dying out, or being exterminated from various causes, while a hybrid or varietal form might continue an independent existence; so that the absence of one or both parent forms from any given locality could not necessarily disprove hybridity, though it might weaken evidence for it.

In the case of the other fern which I also publish here for the first time, it might be claimed with much show of reason that it is a hybrid between *Aspidium Thelypteris* and *A. Noveboracense*, especially from the circumstances under which I found all three ferns growing on Indian Point, Georgetown, Maine; but as there are other and stronger reasons for not accepting that view I have preferred to consider it as a distinct species.

My thanks and acknowledgements are due to Prof. Daniel C. Eaton for having placed in my hands for investigation, with privilege to name and publish, the original specimens of the new hybrid which he received from Mr. Dodge; and also to Mr. Dodge for the privilege of visiting the Essex county stations for both ferns with him, and especially for the valuable critical observations on the habits and characters of both ferns subsequently sent to me by him, and to which I have been greatly indebted while making my own investigations.

In considering the question of nomenclature I have adhered to the Swartzian generic names as Swartz was the first to reduce fern genera to any kind of order, and it is better to keep his names than to use names of only partial and doubtful application given by writers who knew very little about the subject.

I do not recognize the authority of the makers of the Rochester and Madison codes, nor can I approve of the methods by which final judgment is forestalled, and I do not consider that any one is bound by them.

I believe in the desirability of uniformity, and am ready to sacrifice my own opinions without hesitation whenever Kew and Cambridge, Paris and Berlin shall agree upon some universal basis, but until that time I prefer to be guided by the principles laid down by the illustrious de Candolle, and lately substantially reaffirmed in the recommendations made to the Botanical Section of the American Association in August, 1894, by the committee on the nomenclature of plant diseases.

The name ASPIDIUM was first used by Swartz for the whole genus very nearly as it is now understood, and it ought to be retained as there is no earlier name with the same scope and application.

However if any think otherwise and prefer to divide Aspidium into two genera they can use either Dryopteris, Nephrodium or Lastrea for the Aspidia with reniform indusia, and for the benefit of such persons I have appended to my descriptions synonyms from which they can choose whichever suits them best.

Aspidium cristatum × marginale, n. (hybrid) sp.—Rootstock caudiciform, stout, erect or sub-erect, crown central as in A. marginale, shaggy with large pale brown ovate and ovate-lanceolate scales: fertile fronds 1½ to 2½ft tall, 4 to 8in broad across the middle of the lamina; sterile fronds one-half to two-thirds as large; stipites 4 to 12in long, stramineous, strongly channelled, usually well clothed, especially below, but sometimes quite naked or sparingly scaly, with pale brown ovate-lanceolate or linear-lanceolate scales: laminæ 10 to 20in long, elliptic-lanceolate narrowing both ways, the lower one-third usually with triangular ovate obtuse pinnæ as in A. cristatum, but sometimes as in A. marginale, the upper two-thirds more like A. marginale in outline with long acuminated deltoid-lanceolate or lanceolate pinnæ and narrowing gradually to the acuminate apex; pinnæ variable, sub-sessile, short-stalked, distant, approximate, alternate or opposite, 2 to 4½in long, ¾ to 1½in broad at base, narrowing gradually to the acuminate apices, deeply pinnatifid one-half to two-thirds of the way down with oblong or sub-falcate entire or finely serrated divisions, the basal ones cut nearly to the mid-rib and again pinnatifid with finely toothed lobes, texture sub-coriaceous; rachis stramineous and, as well as the midribs beneath, usually scaly with minute scales and chaff; venation as in A. cristatum, but more strongly depressed on the face and sometimes with the wavy blackish midribs and veins of A. marginale: sori nearer the margins than in A. cristatum, indusia smooth, convex before maturity as in marginale, spores few.

Habitat: Borders of swamps with A. cristatum and A. marginale near the bases of rocky land congenial to the latter. Collected in Boxford, Newbury, and Merrimac, Essex county, Mass., 1892, by Raynal Dodge of Newburyport.

The principal characters by which this fern is to be distinguished from A. cristatum, for which it is most likely to be mistaken, are (1) the character of the rootstock, this having a central crown surrounded by fronds, while in A. cristatum the growth is lateral, extending beyond the fronds; (2) the broader outline of the upper two-thirds of the frond, the longer acuminated apex, and the acuminate pinnæ.

The strongest resemblances to A. cristatum are in the young and sterile fronds, but a careful observation of several plants grown on my own grounds during the past year has shown marked differences that a practiced eye will readily detect.

Mr. Dodge reports finding in August last a single plant in a swamp in Warren, Rhode Island, and it may be looked for wherever A. cristatum and A. marginale grow near each other under favorable conditions.

I have also found it recently (in October), within Middlesex Fells Reservation in Medford, growing under the conditions I have indicated; A. cristatum, A. marginale, and the hybrid near together, with plenty of A. marginale on contiguous ledges, and A. cristatum with its variety Clintonianum, A. Boottii and A. spinulosum scattered throughout a half-acre bit of swampy woodland.

Mr. Dodge notices a disposition on the part of this fern to produce abortive fronds, and I have found that it maintains this disposition under cultivation.

Aspidium simulatum, n. sp.— 1 to $3\frac{1}{2}^{ft}$ high; rootstock rhizomataceous, wide creeping, slender, brownish: fronds approximate along the extensions or clustered near the growing end; stipites 6 to 20^{in} long, stramineous, brownish at base, sparingly and deciduously scaly; laminæ 7 to 22^{in} long, 2 to $7\frac{1}{2}^{in}$ broad, oblong-lanceolate, gradually (or in the fertile fronds abruptly) narrowing to the long acuminate pinnatifid apex, pinnately divided into from twelve to twenty pair of elliptic-lanceolate deeply pinnatifid sessile pinnæ, the lowermost pair as a rule introrse, apices acuminate, the obtuse oblique or oblong divisions entire or slightly toothed, the basal divisions of the lower pinnæ sometimes cut quite to the midrib, margins only partially revolute in fruit, but the whole pinna often conduplicate, texture herbaceous, surfaces, especially along the midribs, finely pubescent, the margins ciliately so, color varying, even in contiguous plants, from light to dark green, turning brown with age; rachis stramineous; venation simple, pinnate, rarely, in one abnormal plant only as far as I have seen, with a few of the lower veins once forked: sori much larger than in either of its congeners, indusia finely glandular, sporangia and spores brown when mature.

Habitat: Woodland swamps, thriving best in deep shade near cool moist hummocks, in beds of sphagnum. Originally collected in Seabrook, Essex co., Mass., about 1880, by Raynal Dodge of Newburyport, and more recently by him there, and also in Salisbury in several localities. Found growing abundantly on Indian Point, Georgetown, Maine, by myself in June, 1893, and in nearly full possession of a deep swamp in the Blue Hills Reservation, Quincy, Mass., Sept. 1894. It has also been collected in Purgatory Swamp, Dedham, Mass., by Judge J. R. Churchill, Sept., 1889, and there are two fronds from Stoneham, Mass., without date, in the collection of ferns bequeathed to the Appalachian Club by the late Mr. E. H. Hitchings. There is every probability of its having been collected many times as A. Thelypteris or A. Noveboracense and botanists should compare their specimens carefully.

This fern is intermediate between *A. Thelypteris* and *A. Noveboracense* showing resemblances to both. There are, however, few species in any one genus that are separated from one another by stronger and more distinctive characters than those which separate it from those two ferns, and the only explanation for its having so long escaped recognition is to be found in the fact that no one would think of looking for, or expect to find among the ferns a new species within the limits of the Manual, such varying forms as might be noticed naturally being referred to the nearest species.

Once attention is called to it, however, its recognition becomes comparatively easy and no one would a second time mistake it for A. Thelypteris, from which it is distinguished by its simple venation, larger sori and glandular indusia; or for A. Noveboracense from which it is distinguishable by its Thelypteris-like fronds; and from both of which it is soon known by one of those indefinable graces of appearance that sometimes gives character and tone to a plant just as a certain air or carriage oftentimes distinguishes one person from another.

The new fern is also somewhat later than either A. Thelypteris or A. Noveboracense. On Indian Point I found the young crosiers just beginning to unfold while those of A. Thelypteris and A. Noveboracense were from six to eight inches high, and in the Quincy swamp matured plants were fresh and green when A. Noveboracense in the neighboring woodlands had become brown and yellow.

Unlike A. Thelypteris, too, this fern is at its best in the deep shade of cool swampy woodlands, growing naturally and fruiting heavily under conditions where A. Thelypteris is invariably weak growing and sterile.

Mr. Dodge's observations and my own agree very well not only on the points mentioned but in others to which he called my attention, and I am under great obligations to him for the pains he has taken to furnish me with so much valuable information as he has done.

The name which I have given to this fern was selected partly on account of its resemblance to A. Thelypteris and A. Noveboracense, but more especially on account of its remarkable simulation of a narrow woodland form of *Asplenium Filix-fœmina* which almost invariably has conduplicate pinnæ when growing in the sun.

I append the following synonyms of the two ferns here published for the use of those persons who reject Aspidium:

ASPIDIUM CRISTATUM × MARGINALE Davenport.
Dryopteris cristata × marginalis. Nephrodium cristatum × marginale. Lastrea cristata × marginalis.

ASPIDIUM SIMULATUM Davenport.
Dryopteris simulata. Nephrodium simulatum. Lastrea simulata.

NOTE.—It was my intention to have had some outline figures showing the resemblances, differences and special characters of these ferns and their related species, but unavoidable circumstances have compelled me to defer them until some other time.

Medford, Mass.

Some notes on the Leguminosæ of Siam.

GLENN CULBERTSON.

During the latter portion of a few years residence in Siam, I spent many interesting hours in the study of the flora of that almost untouched botanical field. My work was chiefly upon the plants in the immediate vicinity of Bangkok, the specimens having been collected during short walks on the outskirts of the city, or during more or less extended house-boat trips through the many canals intersecting the city and much of Lower Siam.

On examining the list of a collection of about four hundred plants, with a view to comparing the number of species in the seventy orders represented, I was somewhat surprised to find that of these four hundred specimens, which composed the greater part of the flowering plants in that immediate vicinity, seventy-six were of the order Leguminosæ. These species were found in thirty-eight genera; twenty-two of these genera were found under the sub-order Papilionaceæ, eight under Cæsalpineæ, eight under Mimoseæ. This is a very much larger proportion of the last two suborders than is found in a temperate climate. Gray's Manual of Botany gives Papilionaceæ thirty-two, Cæsalpineæ four, Mimoseæ two; while Coulter's Rocky Mountain Botany gives seventeen, two, and one respectively.

A few of these plants have most probably been introduced, but at least ninety per cent are native.

Of the Papilionaceæ the genus *Pterocarpus*, of which there are two species (*P. indicus* and *P. macrocarpus*), is easily first in commercial importance, although last on the list botanically considered. Both species are rather large trees with very hard and beautiful wood, somewhat similar to mahogany but coarser grained. The wood from the roots and from large knots or protuberances is much darker than that of the trunk and is richly variegated. This wood is very highly prized by the Siamese and Chinese for ornamental purposes, and a great many beautiful betel boxes and other valuable articles are made from it. Some very good specimens of this wood, probably bearing the native name "padoo" or "padu", were exhibited at the World's Fair at Chicago. If distance were not too great a barrier, it would find a ready market in this country for veneering purposes.

Another tree, very common farther north in Siam, is the bastard teak, *Butea frondosa*, named most probably from the striking similarity in the appearance of the leaves to those of the teak tree. It blooms during the dry season in January or February, when the leaves have fallen; and the geat abundance of its large bright orange-red flowers certainly places it first in gorgeousness, and if second in beauty, it is second only to the famous *Poinciana regia*. Even then it is not from lack of beauty in the flowers, but rather from the absence of contrasting foliage.

It is on the twigs and small branches of this tree, as well as the banyan and one or two others, that the little insect, *Coccus lacca*, makes its home, and causes the production of stick lac. Every year a great many long, low-roofed boats from the north come down the Menam to Bangkok, loaded with small branches of Butea frondosa, thickly incrusted with this valuable amber-colored gum.

Plants of the genera *Erythrina* and *Sesbania* are small trees. Of the three species of *Erythrina*, all are very striking in appearance, because of the dense racemes of exceedingly showy coral-red flowers. These also appear during the dry season as do almost all Siamese flowers of any marked beauty.

Sesbania grandiflora is a great favorite of the poorer people, on account of the edible qualities possessed by the young shoots, leaves, and flowers, which are eaten as a vegetable with their curries. Nowhere, I suppose, are there leguminous flowers of larger size than those of this tree. The petals are fully four inches long, and when the flower is open, the tip of the broad recurved standard or upper petal, is at a distance of five or six inches from the tips of the wings and keel. One variety has pure white flowers and another dark red. Man, it seems, is not the only animal that has a liking for these flowers as an article of food. The huge flying fox bats also consider them a great delicacy. On almost any moonlight night, several of them could be seen, from the ever open windows of our dwelling, as they came screeching to one another, and flapping their broad wings (sometimes four or five feet from tip to tip) to alight on the trees, where they hung head downwards or reached out their ungainly thumbs for another flower or branch.

Uvaria crinata, a rather insignificant looking shrub, deserves mention because of its long dense cylindrical racemes of beautiful pink flowers, and the peculiar habit of the pedicels curving inwards after flowering, and pressing the three to five jointed short pods firmly against the strong rachis. I have never seen more dense and enduring racemes of delicate and beautiful flowers than those of this plant. It is certainly worthy of wide introduction as an ornamental plant.

Among the twining Papilionaceæ no species is more delicate and retiring than the wild licorice plant, *Abrus precatorius*. It is sometimes grown as an ornament around native dwellings, partly on account of the flowers and partly on account of the bright scarlet seeds which have a black spot around the hilum. The seeds are prized as ornaments, and are used by jewelers and druggists as one grain weights. There is a strong taste of licorice noticeable in the leaves and stem but especially in the roots, which, judging from the large amounts seen in the shops, are extensively used for the same purpose as the true licorice root.

Several species of *Clitoria* and *Canavalia* are quite interesting, but space will not permit a description. Before noticing some of the more prominent species of Cæsalpineæ, I must mention the shrubby *Flemingia strobilifera*, which grows in clumps resembling the American hazel bush in general appearance. The inflorescence consists of many flowers arranged along each side of a zigzag rachis. The one to three flowered peduncles are enclosed within broad persistent bracts, which in many cases effect a complete exclusion of insects at the time of flowering.

Of the Cæsalpineæ, the most beautiful and probably the best known to the world of all the trees in Siam, the teak excepted, is the *Poinciana regia*. Truly queenly, the prevailing and almost glaring scarlet of its myriads of flowers is delightfully softened by the pale yellow of a single petal in each, and by the rich green of the large, feathery, minutely divided, compound leaves. This tree with its wide-spreading branches can be seen at a great distance, and although in all probability an introduction of many decades past, it has taken a firm hold upon the hearts of the flower-loving Siamese. From a distance the flowering tree strikingly resembles a large fire, which resemblance, no doubt, gave origin to its Siamese name, "the flame of the forest."

Of the genus *Cæsalpinia*, two species are rather peculiar, especially to an inhabitant of a cooler climate. One, *C. bondcealla*, is an extensive woody climber, sometimes reaching to a distance of seventy feet or more on each side of the parent stem, and a jungle where there are many of these plants is next to impassable because of the binding power of the branches, covered with strong recurved prickles.

C. pulcherrima is a small tree frequently planted for ornamental purposes. The copious, wide-spreading, terminal racemes of reddish orange or yellow flowers, cause the tree to appear like a great bouquet. It has been named the "peacock tail tree" by the Siamese.

Of all the genera of Leguminosæ represented, I think no one has a larger number of species than *Cassia*. Of these *C. fistula* is the most noticeable. It is a medium sized tree, which during the hottest part of the dry season is literally loaded with great bunches of large bright sulphur-colored flowers. Here again, the absence of leaves at the time of flowering is conspicuous. The pods of this tree are cylindrical and from fifteen to twenty-four inches long. The seeds of *Cassia tora* are gathered by very poor people, and used as a substitute for coffee.

Saraca cauliflora is a large wide-spreading tree with beautiful clusters of reddish-orange flowers. These flowers are long and tubular and without petals, with seven stamens arising from the throat of the calyx tube.

The tamarind is found in great abundance over all of southern Siam, and is one of the most useful of all the trees in the country. The wood is heavy and hard, and is used for various purposes. The flowers, young leaves, and especially the great abundance of reddish, sour pulp, which surrounds the seeds, are very palatable. The latter furnishes a very agreeable sauce, which is eaten by all classes with rice and curry.

Among the species in the suborder Mimoseæ, *Neptunia oleracea* is one of the most curious. It is a prostrate plant with sensitive leaves and pretty little heads of yellow flowers. Its most peculiar feature, however, is a provision for obtaining light and air, when it happens to grow out over the water, which is very frequently the case. At such times it develops a great abundance of very porous spongy tissue around the stem between the nodes. The ordinary stem is usually less than one-fourth inch in diameter, but when the floats have developed they measure fully an inch across.

Few trees are more handsome than the lofty *Parkia Roxburghii*. Although we hardly expect such large plants in this suborder, some of these trees measure fully seventy feet in height, and with their large twice pinnate leaves and remarkable flowers, they present an appearance not soon forgotten. The inflorescence consists of long pendulous racemes usually with three heads of flowers. These heads are as much as two and a half inches in diameter, and below this there is a neck of similar flowers one inch or more in diameter, and still below this is a fringe of flowers containing long stamin-odes, which in appearance remind one of the broad ruffs of Queen Elizabeth's time. From these peculiar white heads, each of which contains a hundred or more separate flowers, as many as a dozen or fifteen pods, a foot or more long and one or two inches broad, are produced.

Several *Acacias* are found, one of which, a prickly climber, often binds the tops of high trees together by means of its ramifications, although the stem at base may not be more than three or four inches in diameter. *Mimosa pudica*, with its pretty little pink flower heads and peculiar skeleton-like pods, is only too abundant, and must be classed with such pests as the thistle, nettle, and briar, with us.

In continuance, I could mention the thick woody pods of *Xylia*, which, under the influence of the hot afternoon sun, burst with a loud report and scatter their seeds through the forest to quite a distance from the parent stem, as do the pods of one species of *Milletia*; or I might speak of the delicate clover-like *Desmodium triflorum*, or the huge beans of *Canavalia ensiformis*; but sufficient has been given already.

Hanover College, Hanover, Ind.

BRIEFER ARTICLES.

Intelligence manifested by the swarm-spores of Rhizophidium globosum (A. Br.) Schroeter.—Some algæ, mostly species of Spirogyra, collected during November, at Ithaca, N. Y., were kept in the laboratory in open vessels by a cool window. During an examination of this material Dec. 18th, at 12:50 P. M., several nearly mature zoosporangia were observed attached to a thread of Spirogyra. The zoosporangia were full size and the contents coarsely granular. These were mounted in water in a VanTieghem cell and kept for observation of the escape of the zoospores. At 2 P. M. the protoplasm was segregating into isodiametric masses, the beginning of the zoospores.

There was no opportunity for farther examination of the preparation until 5:30 P. M. of the same day when fortunately the zoospores were escaping, about one-half having already made good their escape. One was at the moment squeezing itself through the rather small ostiolum at the apex of the zoosporangium, while the others were sailing about within it. Lying at the ostiolum, the body of the zoospore against the wall of the zoosporangium, the swarm cell begins amoeboid movements by throwing out the granular portion of the protoplasm at the end opposite from that which contains the hyaline sphere. Beside the extension of this part of the swarm cell the extruded portion also moves about over the inner surface of the wall in the effort to find the opening. When this is accomplished the flowing of the protoplasm continues, moving the body of the cell into the ostiolum. The anterior end of the amœboid cell having passed through the opening, enlarges, thus forming a constricted portion at the point of passage. At first the enlarged portions are of unequal size, the outer part being the smaller. This increases in size as the protoplasm flows through until the two parts are equal, when the cell is dumb bell shaped. Soon the outer portion is the larger and finally the entire mass of the protoplasm has flowed through, and the cell gradually assumes the oval form which it possessed before the attempt at passage. It remained poised at the ostiolum for a few moments as if getting itself in form again during the transition from the amœboid form to the swarm cell form, when suddenly it darted away.

When there were but few swarm cells in the sporangium it was easy to note the maneuvers by which the cell determined the location of the ostiolum. The swarm cell swung violently in irregular circles apparently usually keeping quite free from the walls of the zoosporangium.

Then it would come to rest at any point, there seeming not to be any choice in the location. Amoeboid movements would begin as described above for the cell which was first seen passing through the ostiolum. The extended process would feel about over the inner surface of the wall for the desired opening. After a few moments of vain search, if it did not happen to be located at the ostiolum, it would assume the rounded form again, dart violently away and repeat the circular gyrations. Frequently as it swept across the field it seemed to be of a somewhat flattened form, but this may have been due to slight amoeboid movement during the swarming, produced by the unequal pressure in the water encountered in turning suddenly at a different angle. Again it would come to rest and by amoeboid movements search for the ostiolum, and, failing, would again swarm violently about for another period. This would be kept up until the cell happened to rest close by the ostiolum when by amoeboid movements the search would be rewarded by finding the passage, when the issuance would be slowly made.—GEO. F. ATKINSON, *Cornell University, Ithaca, N. Y.*

The wild rice of Minnesota.—In a recent conversation with Dr. Elliott Coues, the well known naturalist, who had just returned from a visit to the head-waters of the Mississippi, some interesting information with regard to wild rice was brought out and in response to my request for some written notes on the subject Dr. Coues forwarded the appended account of the plant. When it is known that the 32,000 Ojibwa Indians depend upon the native wild rice of northern Minnesota as their staple article of vegetable food, the importance of this plant from an economic stand point is at once apparent, and these facts are suggestive of its further commercial utilization.—FREDERICK V. COVILLE, *Washington, D. C.*

WASHINGTON, D. C., Oct. 28, 1894.

Dear Sir:

Referring to our conversation of yesterday, on the wild rice or *Zizania aquatica*, I was somewhat surprised to be informed that there was anything not generally known about this plant in the observations which I made during my recent canoe-voyage to the sources of the Mississippi river. I comply with pleasure with your request for some notes on this subject.

Wild rice figures as a staple food-product in the earliest historical accounts we have of the various Indian tribes which then inhabited northern Wisconsin and Minnesota. One of these is in fact named from this circumstance. But it would be a great mistake to presume that the case is entirely different now. Rice continues to be a staple commodity among all the bands of Ojibwa Indians on the reservations in Minnesota, both for their own consumption and for sale or barter. It has a quotable commercial value with the traders. The article is so well known and generally used that it is found convenient in the trade to distinguish our cultivated rice, *Oryza sativa*, as "white rice." During my trip, I subsisted in part on Indian rice, as it is generally called, which I bought of a trader, as one may purchase cultivated rice of his grocer in this city. In northern Minnesota the whites have invented the verb "to rice," and speak of "ricing," i. e., harvesting the crop of wild rice.

This plant grows in profusion nearly throughout the region I traversed in northern Minnesota. Its ubiquity is attested by the unusual number of lakes, rivers, and creeks which are geographically known by its name. Any lake where the plant occurs in harvestable abundance is a "rice lake," whence the transition to Rice Lake as a specific designation is easy and natural. I should imagine this geographical name to be duplicated a score or more times in Minnesota alone, to the great annoyance or confusion of geographers. Many of these waters are also alternatively known by the corresponding Indian name Manomin, in several of the different forms in which this word is spelled by the whites. I never heard the plant called "oats;" it is always "Indian rice," or "wild rice," or simply "rice."

Zizania aquatica is specially luxuriant in still or slow waters with rich muddy bottoms, and grows more sparsely or not at all in grounds where the current quickens or the soil is sandy, or both. Hence it is rather a plant of the lakes than of the streams. I speak more particularly of its growth in harvestable quality and quantity. For there are innumerable places where it appears, scattered in loose patches over large tracts, not growing thick enough, and not "heading up" well enough, to be worth the trouble of gathering. Lakes where a harvestable crop can be gathered are regularly resorted to at the proper season by all the Ojibwa Indians now living on the various reservations in northern Minnesota. Those that I met, of whom I can speak from personal observation, were chiefly the various bands living about Lake Winnibigoshish, Lake Cass, and Lake Bemidji. They generally cultivate their little fields of maize, and potato-patches; but the wild rice which they gather seemed to me to be their staple article of vegetable food. On Aug. 31st, I found the village deserted at Raven's Point, on Lake Winnibigoshish; the inhabitants had "gone ricing." I frequently met canoes en route, whose destination was some rice-field in the vicinity, as evidenced by the pole with a crotch at the end, something like a long-handled pitch-fork, with which they gather the grain. The stalk is never cut as we reap our cereals; the canoe, generally containing two persons, is pushed into the patch of rice, bunches of the heads are bent over the boat; the grains are beaten out, and suffered to fall loose in the canoe, or on a piece of cloth spread to receive them. The period of harvesting is quite brief, as the grains are not loose enough to be beaten out of the heads till they are ripe, and then they soon fall into the water, to be lost, if not promptly garnered.

In paddling up the Mississippi, and many of its tributaries, one becomes aware that he is approaching a rice-lake by the increasing frequency or density of the patches of the plant he passes, alternating with the reeds (*Phragmites communis* or *P. phragmites*) and other aquatic growths, and in some places entirely supplanting them.

These sporadic growths obviously result from seeds which have floated down the current and taken root, perhaps in their turn to give rise to patches of rice of considerable extent, under favorable conditions of soil and water. But these straggling tracts by the river-side are insignificant in comparison with the dense growth of the plant in certain lakes, where it crowds out other vegetation almost entirely. The first crop of rice I happened to see was that on the little lake which forms the discharge of the Pinidiwin river, and is variously known as Pinidiwin Lake, Manomin Lake, and Rice Lake; it enters the Mississippi by a short thoroughfare, from the N., in the N. W. quarter of section 24, township 146 N., range 35 W. of the 5th principal meridian. This body of water, of roundish figure and about a mile in diameter, is almost an unbroken field of rice, growing so luxuriantly that it overtops the head of the canoeman and shuts in his view completely. The deepest part of such a lake is generally open or only broken by the bulrushes (*Scirpus lacustris*); next shallower water favors the prevalence or entire predominance of rice; then comes the shallowest places, generally around the edges, where phragmites grows, to be in turn supplanted by the rank but nutritious grasses of the adjoining haying-meadows.

There is a great difference in the stature of the rice, as well as in the length and thickness of the fruiting heads, according to topical conditions of growth. Some of it is only two or three feet high, with small heads two or three inches long, but under the most favorable circumstances the stalk may shoot up to six or eight feet, possibly ten, and the head be as many inches long, nodding under the weight of the ripened grains. The heads are for the most part of a pale green color with a tinge of yellowish, but generally acquire a purplish shade at maturity. The grain makes good food; it is nutritious, tastes very much like cultivated rice, and is cooked by boiling in the same way. But the commercial article—at any rate the sample I saw—has a dirty appearance due to mixture with dark brown or blackish specks which look to casual observation like little bits of sticks. What part of the seed or its husk this represents, botanically, you probably know better than I do. It seemed to me to belong to the grain itself, as if it were the persistent beak of the carpel. I presume that this is what makes them call the cultivated product "white" rice, in distinction from the speckled native product. I understand that different grades or qualities of wild rice are distinguished in the trade, the best article being that which is freest from the dark specks. When boiled, the grains swell up, but not quite like those of our rice, for they acquire a curious curl or twist.

In estimating the total value of this rice-crop as a food-product, we should not forget to take into consideration the myriads of wild fowl which eat it almost exclusively at the proper season, and are eaten in turn by both whites and Indians.

Very truly yours,
ELLIOTT COUES.

Salsola Kali tragus.—As the introduction and dissemination of weeds are receiving much attention from botanists, some facts regarding the first appearance of the Russian thistle in Chicago and vicinity will be of interest as way-marks indicating its progress eastward. I first noticed it in August, 1890, when a patch of a dozen or more plants was found by Wolf Lake, on the eastern border of the city. They were on a side track of the Pennsylvania R. R., about a mile from the main line. The boundary line between Illinois and Indiana crossed the track so obliquely at this point that both states were represented in the small area they occupied. A month later others were found at Clarke, Ind., a station in the pine barrens, nine miles east of the boundary line, on the main line of the railroad. In a couple of years the plants had spread considerably, and in 1893 were very abundant on the branch of the road running to Hammond and East Chicago. In late autumn one would come upon them blown about the fields as tumble weeds, though as yet but few are found growing in fields. They are well represented on railroads in the southern and eastern portions of the city, and along those crossing the northern part of Lake co., Ind., within three or four miles of Lake Michigan, and probably much beyond. In August, 1894, I found a few at English Lake, Starke co., Ind., seventy miles from Chicago.

The fewness of the plants in each of these localities indicates that the season in which they occurred was about the first of their appearance. The specimens were generally rather small, but examples two or three feet in diameter are not rare now.

These plants were, at the time of finding them, identified as *Salsola Kali* L., and were so published in "The Flora of Cook County, Illinois, and a part of Lake County, Indiana."[1] They were afterwards mentioned under the same name in notes contributed to the BOTANICAL GAZETTE.[2] Subsequent study of the plants and comparison with specimens from Nebraska led to their identification with the variety *tragus*.—E. J. HILL, *Chicago, Ill.*

Lemna Valdiviana.—I have collected and floated out a large number of sheets of *Lemna Valdiviana* Philippi, discovered lately in Randolph, Mass., by Dr. George G. Kennedy. As the station is an interesting one, the plant will be desired by botanists, and I shall be very glad to send it to anybody who may ask for it.—WALTER DEANE, *9 Brewster st., Cambridge, Mass.*

Ruled slides again.—I have found them already in some new ones just received from the Bausch & Lomb Optical Co., Rochester, N. Y. I refer to a slide for a stage microscope. It looks as though, when a slide was hot enough to soften it, a stamp had been pressed on it, making clean creases 20×20^{mm}. I hope they can put the price away down, so that every one will get them.—W. J. BEAL, *Agricultural College, Mich.*—[These have been in the market for several years.—EDS.]

[1] Bulletin of the Chicago Acad. of Sci. **2:** 155. 1891.
[2] l. c. **17:** 248. Ag. 1892.

EDITORIAL.

FOR YEARS the *Journal of Botany* has annually had its fling at the Reports of the Missouri Botanic Garden, and the November number affords the last example of this unpleasant spirit. Usually with little or nothing to say of the scientific papers beyond faint commendation, the editor has devoted his energies to ridiculing the annual flower sermon and the post-prandial eloquence at the annual banquet. Unfortunately, since they are embodied in a will, the eccentric ideas of the dead Englishman have to be carried out as rigorously as his beneficent ones are executed gladly. And we may be permitted to suggest to the editor that his own island house so abounds in transparent follies of the same sort that it is really not becoming in him to pelt our few imported windows.

THIS NUMBER of the *Journal* has also its stale gibe at "the reforming zeal of our transatlantic friends", which it now sees manifesting itself in the formation of the Botanical Society of America. Just what connection the organization of this society has with our "reforming zeal" we imagine it would be hard for the editor to state; but he has thrust in his innuendo and his readers are given to understand that this also is part of a huge farce which is being enacted in the transatlantic wilds in the name of botany.

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THAT SAME reforming zeal, which seems so ridiculous in the eyes of our "British-and-foreign" friend, vaunteth not itself and is not puffed up, spite of the good it is accomplishing and the promise and potency of more. It has a most simple mission; it aims only to secure as great accuracy and uniformity of usage as users of botanical language may feel inclined to adopt. It brings together a considerable number of botanists, who, having in view present usage, agree that it is desirable to follow certain principles in nomenclature, or in citation, or in terminology, or in pronunciation. This agreement coerces no one, it denounces no one, it asks no one to acknowledge its "authority." Still less have "its supporters . a case to prove" as the authors of the Flora of Mt. Desert assert. The parties to the agreement have only to submit its principles, clearly enunciated, to those interested, and let each determine whether he is willing by adopting them to be "dictated to by a comparatively few botanists"; or whether he will follow other principles, or none at all. The choice is a simple one, and our friends that follow not with us need not fash themselves over the source of our authority to cast out devils.

CURRENT LITERATURE.

Laboratory manual of vegetable physiology.

The rapid development of vegetable physiology as a pedagogical subject is marked by the increase in text books and manuals. The latest addition to the list is a work that will be received by every teacher of vegetable physiology with much satisfaction. We refer to the laboratory guide to the physiology of plants by Francis Darwin and E. H. Acton,[1] both of Cambridge University, England. Probably there is no English teacher of botany from whom a work of this kind will be so highly appreciated by botanists in general as from Mr. Francis Darwin. The fame of his illustrious father as a keen and original experimenter has to some extent been transmitted to the son, and has been supported and augmented by many profound and admirable pieces of independent research.

The work is divided into two parts. The first and larger part embraces general physiology, including such subjects as respiration, assimilation of carbon, transpiration, growth, and movements due to irritability. It is separated into 269 experiments, a number so large that the prominent topics which have engaged the attention of original investigators at different times are mostly represented. Often several experiments are devoted to the same inquiry, using different methods, and enabling the student to arrive at more or less accurate results. Although many experiments are arranged for the best apparatus obtainable, yet in each case the same principle is illustrated by experiments requiring only simple and inexpensive devices. Sometimes much is left to the ingenuity and judgment of the student. At times this is a good method, especially when the teacher sees that the student does not lose too much time in ascertaining the requisite or suitable procedure, but occasionally this method appears to be adopted by the authors to escape from the description of a tedious process. On the whole, however, the 269 experiments of the first part are admirably suited to illustrate the present status of vegetable physiology from the physical and mechanical side; they will add a fresh interest to laboratory work in this subject.

The second portion of the work, according to the preface, "treats a particular department of physiology in a more special manner;" that is, it is the part devoted to the chemical side of physiology. It is con-

[1] DARWIN, FRANCIS and E. HAMILTON ACTON:—Practical physiology of plants. 12mo., pp. 321. 42 illust. in the text. Cambridge, Univ. Press, 1894. Macmillan & Co., New York, American publishers. $1.60.

ceived in a very different spirit from the first part, however. It is not separated into experiments, but it is a short treatise upon chemical manipulation. In the opinion of the reviewer it is not a work upon chemical physiology, but upon physiological chemistry, and therefore, while admirably devised for teaching the student chemical methods, is not a legitimate part of a book devoted to botany. It occupies less than one-third of the volume.

It is noteworthy that ecological topics, commonly included to a greater or less extent in works upon vegetable physiology, have been wholly excluded.

A word of commendation is due the publishers for the neat and appropriate way in which the printing and binding have been done. An excellent index increases the usefulness of the work.

Alternation of generations.

This subject has long been a prominent one in both botany and zoology, and a clear, incisive presentation of any part of it will be acceptable to a large number of students. It is rare that any subject of such deep biological import and such wide reaching influence as this is more happily discussed and illustrated than in the recent work on gall flies and their production of oak galls by Dr. Hermann Adler,[1] englished with valuable additions by Charles R. Straton.

The alternate generations of gall-flies in certain species are very sharply marked, so much so that the sexual and agamic forms have been described under distinct genera. Mr. H. F. Bassett, of Connecticut, was the first to point out the probable connection between the two states, or rather to indicate that certain monosexual species were genetically connected with apparently distinct bisexual species. It was due to the labors of Dr. Adler, however, to fully establish the fact, and to work out the details in a considerable number of species by means of careful and patient observations and cultures.

The results have been of more than taxonomic importance. We have before us, in fact, a particularly clear and happy exposition of a number of topics which are commanding wide attention at the present time, such as the purposes of alternate generations, advantages of parthenogenesis, function of polar bodies, and the transmission of hereditary characters. Whoever is interested in such topics should not fail to read this attractively written work.

The botanist as well as the entomologist will find the book helpful

[1] ADLER, HERMANN:—Alternating generations: a biological study of oak gall flies. Trans. and edited by Charles R. Straton. 12mo., pp. 198. 3 folded col. plates. Oxford, Clarendon Press, 1894. Macmillan & Co., New York, American publishers. $3.25.

in the narrower domain of his specialty. The diversity of form and internal structure of the galls, and the fact that species are often distinguished more from the excrescence on the plant than from the appearance of the insect, should incite botanists to give them attention. The author takes up the evolution of the gall, its minute structure, and the question of its specific form, and brings forward many new facts and views.

The work closes with a list of the Cynipidæ, a bibliography of the subject, and a substantial index. The publishers have done their part well, providing a clear page, excellent colored plates, and an attractive binding.

A laboratory manual of bacteriology.

New manuals for laboratory use in bacteriology have been numerous of late. The last one comes from the University of Michigan, from a laboratory famous for good work. This volume by Dr. Novy[1] is more in the nature of outlines for the Michigan laboratory, than for general use (which will doubtless account for occasional crudities of diction and looseness of statement), yet many teachers will be grateful for its publication. It is interleaved with blank pages for memoranda, which some persons may consider an inconvenient form in which to keep notes. The directions for laboratory procedure are concise, apposite and easily followed. There are diagnoses, occupying a page each, of about twenty-five non-pathogenic forms and thirty pathogenic forms. A series of good lecture outlines, covering the most important topics relating to the general subject of bacteria, are interspersed with the laboratory directions, indicating the ground which the student should cover by lectures, recitations or additional reading.

Minor Notices.

Dr. W. F. Ganong has distributed his paper[1] on the morphology and biology of Cactaceæ, which contains much interesting information concerning a much neglected and most interesting group of plants. Among the results obtained the following are noted: thorns and bristles are shown to be metamorphosed leaves; every leaf possesses an axillary bud which usually remains single, but in Echinocactus, Mamillaria (Cactus), Anhalonium, etc., the growing point is divided, the forking being neither lateral branching nor dichotomy, but a production of permanent tissue between two parts of the growing point;

[1] Novy, Frederick G.:—Directions for laboratory work in bacteriology, for the use of the medical classes in the University of Michigan. 8vo., pp. 209, interleaved. 2 pl. George Wahr, Ann Arbor, [1894]. $1.50.

[1] Ganong, William Francis:—Beiträge zur Kenntniss der Morphologie und Biologie der Cacteen. Inaugural-Dissertation, Munich. 1894.

the grooves are but the stretching out of the pulvini; the sheath in Cylindropuntia is formed from a coalescence of hairs; species of Opuntia, Cereus, Mamillaria possess honey-secreting structures which are always either ordinary or metamorphosed spines; the transverse rings shown by many thorns are due to alternating zones of air-containing and air-free tissue; the bundle systems of all genera are modifications of the typical system seen in Opuntia. By using a combination of vegetative and floral characters the generic relationships are indicated by the usual phylogenetic diagram. It is very valuable for our systematic work to have such careful morphological studies made, as too much of our work is based upon a very superficial morphology.

The Journal of Mycology appears at such long intervals that a new number is especially noteworthy. The last one is no. 4, the final one of volume seven. It contains 146 pages of printed matter and six plates. Forty-eight pages, however, are devoted to an index of volume seven, and thirty-two to the continuation of the general bibliographical index of mycological literature. The latter is admirably done, and if it could only be reissued on cards, would be invaluable. The number is largely devoted to fungicides, and methods and results of their application. A fungus (*Aschersonia tahitensis* Mont.), new to the country, is reported by H. J. Webber as being of possible economic importance in Florida in checking the abundance of such scale insects on orange and other citrous fruits as secrete honeydew, and thus harbor the sooty mold, a serious fungous disease. Interesting field notes for 1892 by Erwin F. Smith, include especially a notice of root tumors of the peach. Nine articles of foreign literature are reviewed.

Bordeaux mixture as a fungicide is discussed at length by Mr. D. G. Fairchild[1] in a government bulletin from the Division of Vegetable Pathology. The method and completeness of the treatment of the subject much surpass that of the usual bulletin literature, and is greatly to be commended. The history of the adoption of the fungicide, its intimate mode of action, and the toxicology of the mixture are especially interesting parts of the essay. The thorough manner in which the subject is handled in all its bearings makes the work one of the most important contributions relating to fungicides issued up to the present time.

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[1] Fairchild, D. G.:—Bordeaux mixture as a fungicide. Bulletin No. 6 of the Division of Vegetable Pathology. 8vo. pp. 55 Washington, Government Printing Office. 1894.

NOTES AND NEWS.

DR. ALBERT SCHNEIDER is studying the lichen flora of northeastern North America at the Columbia College herbarium.

IN *Garden and Forest* (Nov. 21) Mr. Geo. F. Atkinson discusses the Exoascaceæ of stone fruits, and Dr. B. D. Halsted describes and figures a blight of Cosmos.

PROF. L. H. BAILEY completed some months ago the revision of Gray's *Field, Forest, and Garden Botany*, and the book is now in type and ready for issue by the American Book Co.

DR. D. H. CAMPBELL's forthcoming work on the pteridophytes will be brought out by Macmillan & Co., and will be a book of about 400 pages. It will go into the printer's hands about Christmas.

DR. DOUGLAS H. CAMPBELL presented before the B. A. A. S. at its Oxford meeting a paper on the origin of the sexual organs of the pteridophytes, the substance of which will appear in our next issue.

THE SECOND CENTURY of Ule's *Bryotheca Brasiliensis* is now ready for distribution by Dr. V. F. Brotherus of Helsingfors. The price is the same as that of the first century ($6), of which a few sets still remain unsold.

PROFESSOR C. S. SARGENT in *Garden and Forest* (Oct. 31) describes and figures three hybrid walnut trees growing near Boston. They seem to be hybrids of Juglans regia and Juglans cinerea, and are remarkably intermediate in character.

THE SCREW PINES of Tropical Africa are described by Mr. A. B. Rendle in *Journal of Botany* (Nov.). They seem to keep to the coast line, five species on the west coast, two of which are new, and three on the east coast, all of which are new.

MR. J. C. WILLIS, in *Jour. Linn. Soc.* (30: 284–298) discusses methods of fertilization in species of Brodiaea, Stanhopea, Pimelea, Cotyledon, Hydrolea, Nemophila, and Ziziphora; and also cleistogamy in Salvia verbenacea. Two plates illustrate the paper.

WESTERN CHINA continues to yield a surprising harvest of new species, and in *Journal de Botanique* (Sept.) M. A. Franchet continues his descriptions, among which we note six new species of Corydalis, a new Chelidonium, Acer, Rubus, and two species of Saxifraga.

THE LONG LIST of Scottish Desmidieæ, by John Roy and J. P. Bisset, is brought to a close in the October number of the *Annals of Scottish Natural History*. It is a most valuable compendium, many of the species being critically studied, and quite a number of new species being described.

MR. F. H. KNOWLTON has described (*Bulletin Torr. Bot. Club*, Oct.) a new fossil liverwort from the Yellowstone region. It seems to be questionable whether its relationship is with Marchantia or Preissia, but the new generic name *Preissites* suggests that the burden of proof is with the latter view.

THE GENUS Lathyrus is presented in a paper by Mr. Theodore G. White in the *Torrey Bulletin* (Oct.). In looking over the herbarium material from North and Central America, thirty-three species are recognized, and an artificial key is provided for them. Of these four species are described as new.

IN THE *Torrey Bulletin* for November a number of new plants are described, notably a new Oxalis, by Mr. John K. Small, which has been associated with *O. recurva* in the southern states and with *O. stricta* in the northern states; some new and rare Polygonums also by Mr. Small; five new species from Florida, by Mr. T. H. Kearney; and two new Bolivian genera by Dr. H. H. Rusby.

THE ANNUAL report of the state botanist of New York for 1893 has just appeared. Considerable additions have been made to the herbarium, numerous notes as to the variations of local plants are recorded, and a number of new species are described. In addition to the descriptions of new fungi, a new Carex, which has been known as *C. Emmonsii*, var. *elliptica* Boott, is described by Dr. E. C. Howe as *C. Peckii.*

IN *Bulletin de l'Herbier Boissier* (Sept.) M. C. de Candolle describes some new Asiatic and African Meliaceæ, and gives a plate of his new genus Entandrophragma, which has been referred by Walwitsch to Swietenia. In the same number Prof. R. Chodat presents some extensive studies of certain Protococcideæ, illustrating them with eight colored plates. In the same journal (Oct.) M. R. Buser protests against Ascherson's substitution of Cypripedilum for Cypripedium.

SOME LOWER ORGANISMS found in the exudations from deciduous trees have been studied by Dr. W. Krüger (*Hedwigia* 33:) in pure cultures by the gelatine method. He finds two species of Prototheca, a new genus of a new type of fungus, corresponding to the simplest protococcus-like algæ, and two new species of algæ belonging to the Pleurococcaceæ: Chlorella protothecoides and Chlorothecium saccharophilum. The morphology and physiology of these four species were carefully investigated.

PROF. D. P. PENHALLOW has been studying the anatomy of the wood of North American Coniferæ and will shortly publish a classification of these plants based upon these characters. In connection therewith he has prepared a limited number of sets of type sections which he will issue to subscribers. The sections average about 1^{cm} square, are stained, mounted in balsam and provided with printed labels. Each species or variety is represented by the usual three sections, the entire series embracing 264 slides. The price of the complete series is $120.

THERE APPEARS to be the same difficulty among Germans in writing a text book of botany for beginners as obtains among Americans. A recent review in the Botanische Zeitung of Frank's new text book, entitled *Pflanzenkunde für niedere und mittlere Landwirthschaftsschulen und verwandte Unterrichtsanstalten*, severely criticises the arrangement of the matter, while praising its accuracy. The writer closes by saying that it may be serviceable as a review book for academic classes, but that it is not suitable for lower grade schools, as intended by the author (ein Schulbuch ist es nicht).

THE SMILACEÆ of North and Central America are treated in a posthumous paper by Thomas Morong, published in the *Torrey Bulletin* (Oct.). Following Mr. J. G. Baker, the group is regarded as one worthy of distinct family separation from Liliaceæ. In the New World the family is represented by the single genus Smilax, which has three species in Canada, sixteen in the United States, thirty-two in Mexico and Central America, and about sixty-seven in South America. Of the seventeen species of North America north of Mexico, a new species from Stone Mountain, Georgia, is described, and another from the Florida swamps.

IN THE *Kew Bulletin* (Oct.), among descriptions of new species from Tropical Africa, will be found the description by Mr. Hemsley of a new genus of Umbelliferæ from Mexico, based upon plants collected by Mr. Pringle in July and August, 1894, in the mountains above Oaxaca, and communicated to him by Mr. J. N. Rose. The genus is named *Neogoezia*, being dedicated to Dr. Edmond Goeze of Pomerania, formerly a fellow-student of Mr. Hemsley's. Two other species are referred to the genus, which Mr. Hemsley had heretofore referred to Oreomyrrhis, namely O. gracilipes and O. planipetala of the *Biol. Centr. Amer.* The genus is referred to the Smyrnieæ. This full notice is given for the benefit of American botanists, who are just now very much interested in the Mexican flora, and who are not in the habit of looking into the *Kew Bulletin* for a description of Mr. Pringle's material.

WING-LIKE APPENDAGES on the petioles of a fossil Liriodendron and Liriophyllum are figured and discussed by Mr. Arthur Hollick in the *Torrey Bulletin* (November). He regards these appendages as representing former basilar lobes of the leaf, which in Platanus become "crowded down the petiole until they finally exist as mere stipules," suggesting the question as to the probable origin of stipules. The idea of "crowding down" seems hardly necessary, as the phyllopodium is to be regarded as an axis which has a tendency to develop wing-like appendages at any portion, notably, of course, in the epipodium. If stipules are branches of the hypopodium their origin has simply to do with the branching of that part of the phyllopodium, without any reference to the method of winging to be found in the other regions.

THE EIGHTH annual report of the Division of Forestry gives evidence of commendable industry in this important economic field. To establish a rational forest policy in a comparatively new and hence wasteful country is a very slow process, for it encounters tremendous opposition from ignorance and inertia. It is necessary to collect data so detailed and accurate that there can be no escape from the logic of the situation. It seems that the Atlantic Coast states show 43 per cent. of forest land, the Gulf states 50 per cent., the Lake states 31 per cent., the Interior states 20 per cent., the Rocky Mountain region 10 per cent., and the Pacific coast 30 per cent. The Division holds in manuscript quite a number of important monographs of botanical interest, which, it is to be hoped, may soon be published. The report also contains a full account of German forest management as shown at the World's Fair.

Annual reports for 1893 from three Experiment Stations are upon our table, which have not before been noticed. In the Maine report some studies by the pot method upon the use of phosphates by cultivated plants made by Walter Balentine are illustrated with twenty-one fine plates. In the same report F. L. Harvey writes upon bean and tomato anthracnose, potato and beet scab, and a new weed for the state (*Plantago Patagonica*, var. *aristata* Gray). In the New York report S. A. Beach treats of the life history of Plowrightia morbosa, preventing plum leaf-blight and pear scab, with a partial bibliography of the last topic. In the Wisconsin report F. H. King writes on the distribution of roots in field soils, and E. S. Goff discusses the prevention of apple scab, potato scab and other plant diseases. All these articles are illustrated.

Recent station bulletins include three upon the Russian thistle (Ill., no. 35; Iowa, no. 26; and Colo., no. 28), of which the one by the several members of the Iowa Station staff is especially full and interesting. Fungicides and their use in specific diseases receive attention from P. H. Rolfs (Fla., no. 23) and L. H. Pammel (Iowa, no. 24). The cultivation of flowering bulbs in North Carolina as an industry is treated by W. F. Massey (N. C., no. 107). Peach yellows by L. H. Bailey and the prunicolous Exoasceæ of the United States by Geo. F. Atkinson, both from the Cornell Station (no. 75 and 73 resp.) are two interesting bulletins, more than usually well illustrated. Wild or prickly lettuce is discussed by J. C. Arthur (Ind. no. 52), and the injury to stock from eating squirrel-tail grass by Aven Nelson (Wy., no. 19).

Mr. Aven Nelson, botanist to the Wyoming Experiment Station at Laramie, finds that the squirrel-tail grass (or as it is commonly called there "fox-tail"), *Hordeum jubatum*, is a serious pest to stock. The barbed awns break up into pieces, penetrate the gums, especially alongside the teeth, producing swelling and ultimately suppuration of the gums, and ulceration of the jaw bones and teeth, the latter being so loosened as to drop out. If the animal continues to eat hay containing this grass "the disease progresses till the bony tissue of the jaws is disarranged, the ulcers extend to all parts of the jaw bone and it becomes distorted and enlarged. . . . The marrow-filled interior is changed into great cavities filled with the broken awns. This condition may continue till the cavities extend entirely through the jaw and the tightly packed awns protrude till they may be pulled out with forceps or fingers."

GENERAL INDEX.

The more important classified entries will be found under the following heads: *Diseases*, *Floras*, *Host Plants*, *Journals*, *Necrology*, *Personals*, *Physiology*, *Preparations*, *Reviews*.

Names of synonyms are printed in *Italics;* names of new species, etc., in **bold face.**

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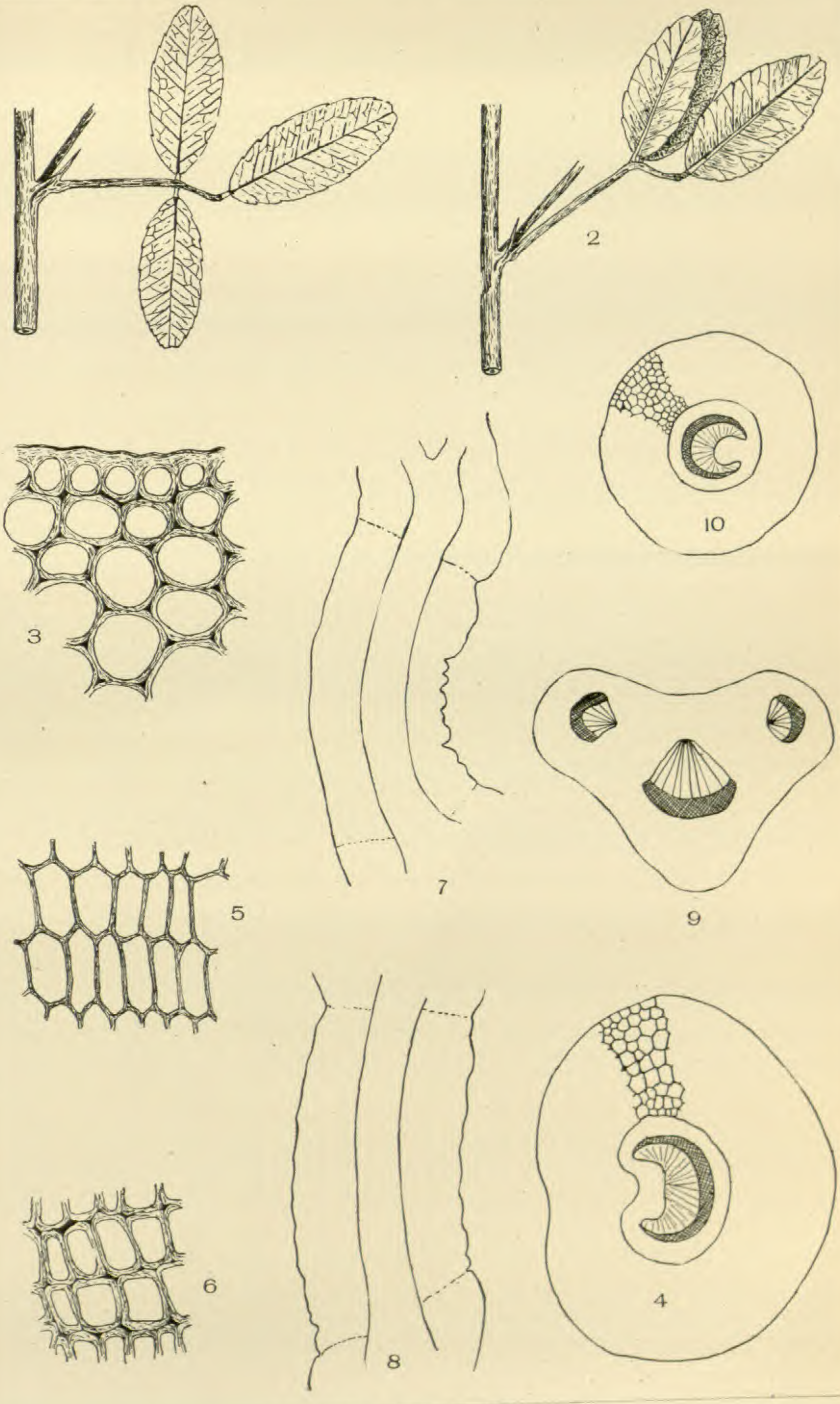

HEALD on PULVINI.